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ABSTRACT

This document contains transcriptions of testimony and prepared statements on national technology policy with a focus on President Clinton and Vice President Gore's initiatives to support the development of a national information infrastructure. On the first day of the hearing testimony was received from Edward H. Salmon, Chairman, New Jersey Board of Regulatory Commissioners; Robert Pepper, Chief, Office of Plans and Policy, Federal Communications Commission; Vinton G. Cerf, Vice President, Corporation for National Research Initiatives and President, Internet Society; Richard R. Green, President and CEO, Cable Television Laboratories, Boulder, Colorado; Brian Kushner, Vice President, Corporate Development, Microelectronics and Computer Technology Corporation, Austin, Texas, and E. R. Kerkeslager, Vice President, Technology and Infrastructure, AT&T, Basking Ridge, New Jersey, representing the Computer Systems Policy Proejct. Witnesses testifying on the second day were Donald A. B. Lindberg, Director, National Coordination Office for High Performance Computing and Communications, and Director, National Library of Medicine; Salim A. L. Bhatia, President, Broadband Technologies, Inc., Research Triangle Park, North Carolina; Sidney Karin, Director, San Diego Supercomputer Center, San Diego, California; Stephen Gage, President, Cleveland Advanced Manufacturing Program, Cleveland, Ohio; T. J. Rodgers, President and CEO, Cypress Semiconductor, San Jose, California; and Jeffrey Kalb, President and CEO, MASPAR Computer Corporation, Sunnyvale, California, representing the American Electronics Association. (KRN)

TECHNOLOGY POLICY: INFORMATION INFRASTRUCTURE [INFORMATION SUPERHIGHWAYS AND HIGH PERFORMANCE COMPUTING]

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
TECHNOLOGY, ENVIRONMENT AND AVIATION

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED THIRD CONGRESS

FIRST SESSION

MARCH 23, 25, 1993

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WITNESSES

TECHNOLOGY POLICY: INFORMATION INFRASTRUCTURE [INFORMATION SUPERHIGHWAYS AND HIGH PERFORMANCE COMPUTING]

TUESDAY, MARCH 23, 1993

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON TECHNOLOGY, ENVIRONMENT AND AVIATION,
Washington, D.C.

The subcommittee met, pursuant to recess, at 9:10 a.m., in Room 2318, Rayburn House Office Building, Hon. Tim Valentine [chairman of the subcommittee] presiding.

Mr. VALENTINE. The subcommittee meets today to continue its hearings on national technology policy. Both today and Thursday of this week, we will focus on President Clinton and Vice President Gore's initiatives to support the development of a National Information Infrastructure.

The President and Vice President's policy statement of February 22nd strikes many themes we would like to explore. One theme is the need for an effective partnership between federal and state governments. A number of our states have studied the contribution that an advanced information infrastructure can make to state economic development. Based on these studies, they have formulated strategies to encourage more rapid introduction of fiber optic communications infrastructure to businesses, to schools, and to homes.

Another theme is the need for government to work in partnership with the private sector to implement policies that will encourage our private sector to make the investments which are necessary to build the high-speed network or so-called information superhighway, which this country will need if it is to compete successfully in the next century.

The network envisioned by the President will most likely evolve from our public telephone network, our cable television distribution system, and other networks such as the National Research and Education Network, or NREN. Our communications networks of today serve a broad array of users and their diverse requirements. Our networking, switching, and other technologies have evolved in a highly competitive environment driven by market forces and consumer demand.

Some of us believe that the President's program envisions that this will continue to be the case. Our communications industry is being dramatically transformed by the rapid pace of technological

change. All communications media are now taking digital form. This, and other technological advances, permit us to envision a universally accessible national network that will permit access by anyone, at any time, in any place to a variety of services. The network will be able to transmit voice, text, data, images, video, and virtually any other format for depicting information. One of the challenges facing us is how to make such a high-speed national information network, and its associated computer resources, an affordable entity to every American citizen.

Another theme in the President's technology policy paper is the commitment to further federal support for research and development under the high performance computing and communications program established by the High Performance Computing Act of 1991. This act has four key components, one of which is the establishment of the National Research and Education Network, as previously referred to, or NREN. NREN is involved—is evolving with—is evolving from Internet, which has demonstrated the value of a public data network for research and education.

However, it has become clear, since the passage of the act, that there are a number of different visions of what the NREN is or should become. Some argue that it should be a federal network of dedicated physical links. They believe that it should evolve into a national, high speed computer data network with universal access for all citizens. Others see it as a national network program where transmission requirements will be supplied by the private sector. Some think the primary emphasis in developing the network should be on the high speeds necessary for the research community. Others argue that ease of use, or user friendliness, is more important to constituents, such as the education community.

Everyone, however, agrees that the NREN will be an important component of our National Information Infrastructure. Today and Thursday, we will hear testimony on these and other issues, from a number of distinguished witnesses.

For our first panel today, we are privileged to have with us two government witnesses: Dr. Edward Salmon of the State of New Jersey and Dr. Robert Pepper of the Federal Communications Commission.

Our second panel—for our second panel, we are privileged to have with us a number of industry and private sector witnesses, which include Dr. Vint Cerf of the Corporation for National Research Initiatives, who is widely regarded as the father of the Internet; Dr. Richard Green, president and chief executive officer of Cable Television Laboratories; Dr. Brian Kushner of the Microelectronics and Computer Technology Corporation; and Dr. E. R. Kerkeslager of AT&T, testifying for the Computer Systems Policy Project.

I want to thank all the witnesses for being here today and for the contribution which they have made, and which they will make.

I'd also like to remind the witnesses, if you would please limit your oral statements to no more than five minutes, your prepared remarks will appear in the record as presented to us. We earnestly request your cooperation, so as to provide an opportunity for all members of the subcommittee to ask questions.

We—Mr. Lewis, the ranking member of our subcommittee, is detained, and Mr.—well, excuse me. Let me get—follow my own rules. The gentleman from Maryland will be recognized to function as ranking Republican member of the subcommittee.

Mr. BARTLETT. Thank you very much, Mr. Chairman. I look forward—

Mr. VALENTINE. We like to do that to be sure you don't have any notice.

[Laughter.]

Go ahead.

Mr. BARTLETT. I look forward to the presentations and hope that we will have an informative exchange. Thank you.

Mr. VALENTINE. And the gentleman from New Jersey, Mr. Klein, do you have an opening statement? We're glad to have you here, sir.

Mr. KLEIN. Yes. Yes, I do. Thank you, Chairman Valentine.

I've been looking forward to this hearing for some time. We're very proud that New Jersey has been one of the very first to recognize the importance of an innovative approach to telecommunications infrastructure as a vital element of a competitive economy.

I'm pleased to extend a personal welcome to Dr. Edward Salmon, the man who is responsible for implementing New Jersey's telecommunications plan. We are, indeed, fortunate that he is able to make it here today.

Ed is a friend of many years. His intelligence, dedication, and character are unparalleled, and I've also heard he plays a pretty mean game of basketball.

In New Jersey, we are fortunate to have recognized how an advanced telecommunications infrastructure will increase the quality of all aspects of life: from education to health care to economic development, including job creation. Among the key issues that must be addressed before an information superhighway can be made available for public use is how to implement and regulate these new technologies. The first step in this process was to accept the need to analyze, and accept, alternative forms of telecommunications regulation, so that these regulations conform to the individual needs of the State. For time's sake, I won't go into the details of the implementation of New Jersey's telecommunications plan, since I am sure that Dr. Salmon will outline the particular applications of the New Jersey initiative, and be able to answer any questions committee members may have.

The network in New Jersey gives our state the kind of high paying jobs which we are seeking to create and encourage on this committee. The benefits which the New Jersey plan bodes to give to our state, if followed nationally, would bestow on the nation this world technology, this same kind of competitiveness, and the same abilities that I think we are going to receive in New Jersey.

I hope that, as the Science Committee examines the effects of telecommunications policy on competitiveness, we as a nation can learn from New Jersey's example.

Mr. VALENTINE. I thank the gentleman.

The gentleman from California, Mr. Rohrabacher, is recognized for an opening statement.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman.

I am a former journalist, and fully appreciate the importance of communications, and the important role that it's played in information distribution in terms of the progress of our country. But let us note that when we're trying to lay down government plans, that when I first came to Congress four years ago, and as the chairman noted in his opening statement, that digital technology now is considered the technology that we're going to be basing our information on. When I came here four years ago, there was enormous pressure from various interests to subsidize in the hundreds of millions analog technology in terms of HDTV. I mean, this was—and everybody was trying to tell us, those who weren't in favor of this subsidy were actually anti-progress and in some way were going to hold mankind back and we weren't going to be able to lead the way in HDTV. And we now know, after we moved forward with that hundreds of millions of dollars, that it would have been hundreds of millions of dollars right down the old bureaucratic toilet.

So I'm looking forward to hearing the different ideas that are available, and I am in particular interested in making sure that any information highway that comes out of this committee, or comes out of the Congress, is inclusive of all alternatives, inclusive rather than being exclusive of alternative than other approaches. I'm interested in making sure that whatever comes out of here is fullest participation, and also has the maximum leverage to mold itself, and to evolve with the times and with the various technologies that will be developing in the future.

In terms of technological development, I personally believe, rather than government planning, quite often if we left things—if we just, for example, provided research and development tax credits and had some very sincere antitrust and litigation reform in this country, and especially if we had a capital gains reduction so that people could invest their own money in the private sector, that some of these reforms which would cost the government almost nothing in terms of loss of revenue we could actually facilitate the type of changes that we want, and make our society a progressive and technology-efficient society.

So I am very interested in the subject today, Mr. Chairman, and I appreciate your leadership on this. And I know down in North Carolina that you've taken a very positive role in ensuring that technological developments become part of the American mainstream, and I look forward to working with you in this area.

Mr. VALENTINE. We thank the gentleman for his usual intelligent and spicy contribution. Those of you who know our friend, Mr. Rohrabacher, will understand how much trouble the subcommittee staff had to get him to use the word "toilet."

[Laughter.]

Mr. Coppersmith, the gentleman from Arizona.

Mr. COPPERSMITH. Thank you, Mr. Chairman. I'll waive my opening statement. I don't know how anything I could say could really follow the two of you.

[Laughter.]

Mr. VALENTINE. Mr. Salmon, we'll be happy to hear from you.

STATEMENT OF EDWARD H. SALMON, CHAIRMAN, NEW JERSEY BOARD OF REGULATORY COMMISSIONERS, TRENTON, NEW JERSEY; ACCOMPANIED BY ROBERT PEPPER, CHIEF, OFFICE OF PLANS AND POLICY, FEDERAL COMMUNICATIONS COMMISSION, WASHINGTON, D.C.

Dr. SALMON. Thank you very much, Mr. Chairman.

Mr. VALENTINE. Is that high-tech contraption on [referring to the microphone]?

[Laughter.]

Dr. SALMON. Listen, if you can't turn it on, you're in trouble; right?

[Laughter.]

First of all, let me just thank you, and the members of this subcommittee, for the opportunity to be here, and to make some comments on the superhighways of the future in information and telecommunications, and to say to my good friend, Congressman Herb Klein, that I appreciate the invitation, and I appreciate his leadership here in Washington now in representing the State of New Jersey.

I come from three perspectives. One, I've been an elected official for 20 years. I was a mayor. I was a Freeholder Director, which is county government in our state, and I was in the State Legislature, and had responsibility for the committee on economic development, growth, and agriculture.

Twenty-seven years as an educator also gives a viewpoint on what we're looking for, as the future of education and telecommunication, and how the telecommunication industry can make sure that we have an equality of education for all of us. And two years now as a regulator in the State of New Jersey, having the immense responsibility of regulating the utility industry in our state.

Let me just first give you a view of the board that I represent. And to my right is our executive director, Michael Gallagher, for our telecommunication department, and we are called the Board of Regulatory Commissioners in the State of New Jersey. It's the oldest consumer protection board in the state, started by Woodrow Wilson when he was our governor in 1911. And we basically have three commissioners with a responsibility of regulating the six utilities in the State: water and sewer, electric and gas, and telecommunications and cable television.

Of the three commissioners, Commissioner Armenti is from the central part of the state; Commissioner O'Connor is from the northern part of the state; and I'm from the southern part of the state. So it makes a great balance. It's the first time in our history of the State we don't have a lawyer on the commission. I don't know if that's good or bad. We're still trying to figure that out, Mr. Chairman.

And I would tell you that together, the three of us all have been in elected office 67 years. So we have a variety of experiences, on all different levels of government.

I fully support the invitation of President Clinton's technological initiatives aimed at improving and promoting the competitiveness of America. We had an historic case in New Jersey, and I chaired fifteen-and-a-half-day hearings on the issue of advanced tele-

communications infrastructure development, and deployment and alternative form of regulation for local telecommunication carriers.

It was an historic case. There were 13 intervenors. There were over 30 lawyers involved in the case. And we started early in the morning at 8:30, and sometimes didn't end up until eight o'clock at night for the fifteen and a half days of testimony, of highly technical testimony, that we overheard.

I thought I'd give you a little background as far as the history of this case, and the way New Jersey's going about the deployment of advanced telecommunications infrastructure. We think it's historic because we believe we will be the first state in the nation to have a fully fiber optic infrastructure in place, and that will be done by the year 2010.

In 1990, the New Jersey Board of Public Utilities commissioned the New Jersey Telecommunication Infrastructure Study, in order to better understand the relationship between telecommunications and New Jersey's future, especially in the terms of economic development. The study demonstrated a positive linkage between an advanced telecommunications infrastructure and economic development. It also identified several potential areas for public policy development, such as investment incentive mechanisms, conditioning for furthering competition, and opportunities to achieve state educational and health care goals, through this advanced telecommunications capabilities.

On January 17, 1992. Governor James Florio signed into law the Telecommunication Act of 1992. This act substantially revised the regulatory framework for telecommunication regulation that had been relatively unchanged since 1911. This legislation established that it is state policy to permit the board to consider alternative forms of regulation, in order to address changes in technology and the structure of the telecommunication industry, as well as to promote economic opportunity and development.

The predominant local exchange carrier in our state is New Jersey Bell. New Jersey has basically three local exchange carriers. New Jersey Bell is—97 percent of our customers in New Jersey have New Jersey Bell as their local exchange carrier. United Telephone has about 2.9 percent of the market, and Warrick Valley has less than one-tenth of a percent of the market. That certainly makes it a lot easier than if you have 30 or 40 local telephone companies within your state, when you have a major player that has most of the state, with 97 percent.

They applied, and filed, a plan in response to the Telecommunication Act of 1992, New Jersey Bell, which substituted a form of incentive regulation, formula-based price regulation, for traditional rate-based rate-of-return regulation. The plan was filed to enhance economic development in New Jersey, while maintaining predictability and affordability of telephone rates until the year 2000. The plan was filed with New Jersey Bell's proposed Opportunity New Jersey, which is a plan to accelerate the deployment of advanced switching and transmission technologies in the public telecommunications network.

New Jersey Bell anticipates that an additional investment to excel the deployment of advanced network will be approximately $1.5 billion from 1992 to 1999. That $1.5 billion is over and above

the $4.2 billion they already plan to invest, and that will get us to the year 1999. To the year 2010, to complete the plan, will be an additional $3 billion to make sure that we're fully fiber wired, fiber optically wired, with our infrastructure.

Our review of the record and exhibits convinced the board of the need for an alternative regulatory approach, which recognizes the changed telecommunication marketplace, and advanced technologies, embedded in New Jersey Bell's Opportunity New Jersey. A strong, stable infrastructure and responsible economic growth and development will allow the delivery of reliable state services in an efficient and cost-effective manner.

The board approved the plan on December 22, 1992, and probably to show you how historic the order is, the order is going to probably be over 100 pages, and although we approved it December 22, 1992, we still have about two weeks before we'll be ready to release the order. It includes a freeze on monthly residential basic telephone rates for the term of the plan, and that's very important, since local residential basic telephone ratepayers are not paying for the plan, thus assuring that residential telephone customers would not bear any of the burden of additional investment in the advanced network.

Approval of this plan has produced regulatory incentives and safeguards to ensure universal access to advanced telecommunications capabilities on an accelerated basis by giving New Jersey Bell the regulatory certainty it needed to make such a major investment in the network. The plan allows New Jersey to provide an ubiquitous, totally digital and fiber broadband network in New Jersey by the year 2010, 20 years sooner than originally planned and five years earlier than suggested by some as a national goal. And I might also add: five years earlier than Japan will have a totally fiber optic infrastructure in its country.

This common carrier public switch network will be available to all service providers under the same terms and conditions. The initial application of the new advanced tech networks are expected to provide new and diverse communication services, including voice, data, and video services to our businesses, as well as our residential communities. These new services will include, among other things, advanced education, entertainment, and health care applications.

The new service capabilities, together with the investment made to deploy these services, and the capital attracted to use these capabilities, are expected to increase competition, spur local economies, generate greater tax revenue, make the area more attractive to new business, and, most importantly of all for all of us, improve the quality of life for the state.

I'd like to focus on these three most exciting and critical areas which will be affected by the enhanced network in New Jersey: education, health care, and entertainment. First, education: in the education area, distance learning could become the norm throughout New Jersey. This educational tool enables students to take advantage of the classes that are not available throughout their own school curriculum. I see that the State of Iowa is looking at this same advantage. It is already a reality in Bergen County, New Jersey, where the County's 17 high schools and two colleges are joined

in interactive education. Through this innovative telecommunication network, teachers are able to reach the largest number of students possible. Such a network can provide the highest quality education to disadvantaged inner cities and remote rural areas, as well as the most affluent suburbs.

I might just make an addition here to my statement, as my doctorate dissertation was on the quality of funding public education in the State of New Jersey. And when New Jersey had a public education system that relied basically on property tax values, then you had inequality as far as the funding opportunities for each and every child in the state. When you look at this opportunity for education, and providing equal access of education to students, it's certainly a way in which we can meet the constitutional demands of affordable education to all children. As noted at one of our public hearings, distance learning will permit kids in reform institutions access to the highest quality of education available to anyone in the state. All in all, it will make teachers and students more productive.

Second, health: imagine this: a large, diverse medical center with a main hospital in one location, an imaging center in a second city, a computing office in a third, and a records library in a fourth location, all on a fiber network to connect the four locations. The network makes those distances virtually disappear, allowing doctors in effect, to work in many places at once. The hospital's own storage and retrieval system linked to the network allows physicians to review the same data from different locations. By combining video, still picture, voice, and text into a single package, transmitted images can, be as sharp as the originals. Related paperwork, such as a patients files and diagnostic annotations, can be sent with images and doctors can examine an image, or even a whole record in what amounts to a conference call.

Telemedicine and remote diagnosis holds significant promise for the city like Camden, New Jersey. Health care officials in Camden cite a lack of transportation to health care facilities as a primary reason for some disturbing facts. Camden has one of the highest adolescent birth rates among New Jersey's urban centers, yet it ranks among the top ten municipalities in the country in infant mortality. This is largely because Camden's expectant mothers are unwilling, or unable, to obtain necessary prenatal care. Children who do survive are of low birth weight, and receive little routine, preventive medical care. Telemedicine can enhance access to medical treatment for these severely disadvantaged mothers and their children, and the new fiber optic network will make this a reality.

A fiber-based network could partner with mobile medical units to bring quality health care to Camden's underserved population. Such units can visit neighborhoods regularly, to provide basic and preventive care, and acute illness care and followups. They also offer needed health education, special services, information, and counseling. Fiber technology will ensure these services, by providing instant access to medical histories, and to distance medical experts for consultation and diagnosis. Fiber will make remote diagnostics and consultations possible, by linking mobile units with the network of public access points: schools and community centers.

Once the fiber network is extended to the home of all citizens, additional affordable educational and health care opportunities will emerge. Interactive education and health-in-the-home capability will have an important application for the handicapped, homebound, or older citizens—citizens today who are cut off from most educational opportunities, or deprived of adequate health care, because of their lack of mobility.

Third, entertainment: as an outcome of the FCC's video dialtone proceedings and New Jersey's economic development initiatives, we are now at the forefront of the implementation of this national policy. New Jersey will essentially be pioneering the application of video dialtone. New Jersey Bell has filed its Opportunity New Jersey plan, to meet the goal of enhancing the network and economic development. The fiber optic systems currently contemplated for video dialtone are a part of this initiative. There are currently two applications submitted by New Jersey Bell before the FCC to provide video dialtone types of services in our state.

These are just three examples of positive benefits that can result from the advanced public switch networks in New Jersey. It is my firm belief, and my commissioners', that a national network will reap the same benefits, and accomplish many of the administrative goals of promoting competitiveness, of the United States in the global economy of the 21st century.

I'd like to thank the subcommittee for the opportunity to testify today and close with this thought: you have an enormous task in front of you, as we look at what the future of America can be, and realize that we're now in a global economy. And if we want to position ourselves to compete successfully and still be the greatest country, I think the telecommunication network is going to be a key to that effort. And I wish you and your committee members the best of success in moving forward with the President's plans.

Thank you.

[The prepared statement of Dr. Salmon follows:]

TESTIMONY OF DR. EDWARD H. SALMON
BEFORE
THE HOUSE COMMITTEE ON SCIENCE, SPACE &
TECHNOLOGY'S SUBCOMMITTEE ON TECHNOLOGY,
ENVIRONMENT & AVIATION

NATIONAL INFORMATION INFRASTRUCTURE
&
HIGH PERFORMANCE COMPUTER NETWORK
MARCH 23, 1993

- MR. CHAIRMAN THANK YOU FOR THE OPPORTUNITY TO ADDRESS THIS SUBCOMMITTEE ON THIS VERY IMPORTANT ISSUE.

- I FULLY SUPPORT THE IMPLEMENTATION OF PRESIDENT CLINTON'S TECHNOLOGY INITIATIVE, AIMED AT IMPROVING AND PROMOTING THE COMPETITIVENESS OF THIS GREAT NATION.

- AFTER CHAIRING 15 1/2 DAYS OF HEARINGS ON THE ISSUES OF ADVANCED TELECOMMUNICATIONS INFRASTRUCTURE DEVELOPMENT AND DEPLOYMENT AND ALTERNATIVE REGULATORY TREATMENT FOR LOCAL TELECOMMUNICATIONS CARRIERS, I AM INTIMATELY FAMILIAR WITH THE CAPABILITY OF SUCH AN ADVANCED SYSTEM IN STIMULATING ECONOMIC DEVELOPMENT AND PROMOTING THE COMPETITIVENESS OF THE STATE OF NEW JERSEY.

IN 1990, THE NEW JERSEY BOARD OF PUBLIC UTILITIES COMMISSIONED THE NEW JERSEY TELECOMMUNICATIONS INFRASTRUCTURE STUDY IN ORDER TO BETTER UNDERSTAND THE RELATIONSHIP BETWEEN TELECOMMUNICATIONS AND NEW JERSEY'S FUTURE, ESPECIALLY IN TERMS OF ECONOMIC DEVELOPMENT. THE STUDY DEMONSTRATED THE POSITIVE LINKAGE BETWEEN AN ADVANCED TELECOMMUNICATIONS INFRASTRUCTURE AND ECONOMIC DEVELOPMENT. IT ALSO IDENTIFIED SEVERAL POTENTIAL AREAS FOR PUBLIC POLICY DEVELOPMENT SUCH AS INVESTMENT INCENTIVE MECHANISMS, CONDITIONS FOR FURTHERING COMPETITION, AND OPPORTUNITIES TO ACHIEVE STATE EDUCATIONAL AND HEALTH CARE GOALS THROUGH ADVANCED TELECOMMUNICATIONS CAPABILITIES.

- ON JANUARY 17, 1992, GOVERNOR JAMES FLORIO SIGNED INTO LAW, THE TELECOMMUNICATIONS ACT OF 1992. THIS ACT SUBSTANTIALLY REVISED THE REGULATORY FRAMEWORK FOR TELECOMMUNICATIONS REGULATION THAT HAD BEEN RELATIVELY UNCHANGED SINCE 1911. THIS LEGISLATION ESTABLISHED THAT IT IS STATE POLICY TO PERMIT THE BOARD TO CONSIDER ALTERNATIVE FORMS OF REGULATION IN ORDER TO ADDRESS CHANGES IN TECHNOLOGY AND THE STRUCTURE OF THE TELECOMMUNICATIONS INDUSTRY, AS WELL AS TO PROMOTE ECONOMIC DEVELOPMENT.

- THE PREDOMINANT LOCAL EXCHANGE CARRIER IN OUR STATE, NEW JERSEY BELL, FILED A PLAN IN RESPONSE TO THE TELECOMMUNICATIONS ACT OF 1992, WHICH SUBSTITUTES A FORM OF INCENTIVE REGULATION -- FORMULA-BASED PRICE REGULATION -- FOR TRADITIONAL RATE BASE, RATE OF RETURN REGULATION. THE PLAN WAS FILED TO ENHANCE ECONOMIC DEVELOPMENT IN NEW JERSEY WHILE MAINTAINING PREDICTABILITY AND AFFORDABILITY OF TELEPHONE RATES UNTIL THE YEAR 2000.

- *THE PLAN WAS FILED WITH NEW JERSEY BELL'S PROPOSED "OPPORTUNITY NEW JERSEY" WHICH IS A PLAN TO ACCELERATE THE DEPLOYMENT OF ADVANCED SWITCHING AND TRANSMISSION TECHNOLOGIES IN THE PUBLIC TELECOMMUNICATIONS NETWORK. NEW JERSEY BELL ANTICIPATES THAT ITS ADDITIONAL INVESTMENT TO ACCELERATE THE DEPLOYMENT OF THE ADVANCED NETWORK WILL BE APPROXIMATELY $1.5 BILLION FROM 1992 TO 1999, OVER AND ABOVE THE $4.2 BILLION IT ALREADY PLANNED TO INVEST.*

- *OUR REVIEW OF THE RECORD AND EXHIBITS CONVINCED THE BOARD OF THE NEED FOR AN ALTERNATIVE REGULATORY APPROACH WHICH RECOGNIZES THE CHANGED TELECOMMUNICATIONS MARKETPLACE AND ADVANCED TECHNOLOGY AS EMBEDDED IN NEW JERSEY BELL'S OPPORTUNITY NEW JERSEY. A STRONG, STABLE INFRASTRUCTURE AND RESPONSIBLE ECONOMIC GROWTH AND DEVELOPMENT, WILL ALLOW THE DELIVERY OF RELIABLE STATE SERVICES IN AN EFFICIENT AND COST-EFFECTIVE MANNER.*

- *THE BOARD APPROVED THE PLAN ON DECEMBER 22, 1992 INCLUDING A FREEZE ON MONTHLY RESIDENTIAL BASIC TELEPHONE RATES FOR THE TERM OF THE PLAN, THUS ASSURING THAT RESIDENTIAL TELEPHONE CUSTOMERS WOULD NOT BEAR ANY OF THE BURDEN OF ADDITIONAL INVESTMENT IN THE ADVANCED NETWORK.*

- *APPROVAL OF THIS PLAN HAS PRODUCED REGULATORY INCENTIVES AND SAFEGUARDS TO ENSURE UNIVERSAL ACCESS TO ADVANCED TELECOMMUNICATIONS CAPABILITIES ON AN ACCELERATED BASIS BY GIVING NEW JERSEY BELL THE REGULATORY CERTAINTY IT NEEDED TO MAKE SUCH AN INVESTMENT IN THE NETWORK.*

- *THE PLAN ALLOWS NEW JERSEY BELL TO PROVIDE A UBIQUITOUS, TOTALLY DIGITAL, AND FIBER BROADBAND NETWORK IN NEW JERSEY BY THE YEAR 2010, 20 YEARS SOONER THAN ORIGINALLY PLANNED AND FIVE (5) YEARS EARLIER THAN SUGGESTED BY SOME AS A NATIONAL GOAL. THIS COMMON CARRIER PUBLIC SWITCHED NETWORK WILL BE AVAILABLE TO ALL SERVICE PROVIDERS UNDER THE SAME TERMS AND CONDITIONS.*

- *THE INITIAL APPLICATIONS OF THE NEW ADVANCED NETWORK ARE EXPECTED TO PROVIDE NEW AND DIVERSE COMMUNICATIONS SERVICES INCLUDING VOICE, DATA AND VIDEO SERVICES TO OUR BUSINESS AS WELL AS RESIDENTIAL COMMUNITIES. THESE NEW SERVICES WILL INCLUDE, AMONG OTHER THINGS ADVANCED EDUCATION, ENTERTAINMENT, AND HEALTH CARE APPLICATIONS.*

- *THE NEW SERVICE CAPABILITIES TOGETHER WITH THE INVESTMENT MADE TO DEPLOY THESE SERVICES AND THE CAPITAL ATTRACTED TO USE THESE CAPABILITIES ARE EXPECTED TO INCREASE COMPETITION, SPUR LOCAL ECONOMIES, GENERATE GREATER TAX REVENUES, MAKE THE AREAS MORE ATTRACTIVE TO NEW BUSINESS AND MOST IMPORTANT OF ALL, IMPROVE THE QUALITY OF LIFE FOR THE COMMUNITY.*

- *I WOULD NOW LIKE TO FOCUS ON THREE MOST EXCITING AND CRITICAL AREAS WHICH WILL BE AFFECTED BY THE ENHANCED NETWORK IN NEW JERSEY - EDUCATION, HEALTH CARE AND ENTERTAINMENT.*

- *IN THE EDUCATIONAL ARENA, DISTANCE LEARNING COULD BECOME THE NORM THROUGHOUT NEW JERSEY. THIS EDUCATIONAL TOOL ENABLES STUDENTS TO TAKE ADVANTAGE OF CLASSES THAT ARE NOT AVAILABLE THROUGH THEIR OWN SCHOOL CURRICULUM. I SEE THAT THE STATE OF IOWA IS LOOKING AT THIS SAME ADVANTAGE.*

- *IT IS ALREADY A REALITY IN BERGEN COUNTY, NEW JERSEY, WHERE THE COUNTY'S 17 HIGH SCHOOLS AND TWO COLLEGES ARE JOINED IN INTERACTIVE EDUCATION. THIS WAS A GOOD TEST FOR US. AN INITIATIVE FORGED THROUGH COOPERATION BETWEEN NEW JERSEY BELL AND LOCAL POLICY MAKERS. A HIGH SCHOOL STUDENT, FOR EXAMPLE, CAN PARTICIPATE VIA TWO-WAY VIDEO IN A MUSIC THEORY CLASS THAT IS OFFERED IN A HIGH SCHOOL SEVERAL MILES AWAY.*

- *THROUGH THIS INNOVATIVE TELECOMMUNICATION NETWORK, TEACHERS ARE ABLE TO REACH THE LARGEST NUMBER OF STUDENTS POSSIBLE. SUCH A NETWORK CAN PROVIDE THE HIGHEST QUALITY EDUCATION TO THE DISADVANTAGED INNER CITIES AND REMOTE RURAL AREAS AS WELL AS THE MOST AFFLUENT SUBURB...*

- *AS NOTED AT ONE OF OUR PUBLIC HEARINGS, DISTANT LEARNING WILL PERMIT KIDS IN REFORM INSTITUTIONS ACCESS TO THE HIGHEST QUALITY OF EDUCATION AVAILABLE TO ANYONE IN THE STATE.*

- *ALL IN ALL IT WILL MAKE TEACHERS AND STUDENTS MORE PRODUCTIVE.*

- *THE SECOND APPLICATION I WOULD LIKE TO DISCUSS IS HEALTH CARE.*

- *LARGE, DIVERSE MEDICAL CENTERS WITH, FOR EXAMPLE, A MAIN HOSPITAL IN ONE LOCATION, AN IMAGING CENTER IN A SECOND CITY, A COMPUTING OFFICE IN A THIRD AND A RECORDS LIBRARY IN A FOURTH LOCATION, COULD USE A FIBER NETWORK TO CONNECT THESE FOUR LOCATIONS. THE NETWORK MAKES THOSE DISTANCES VIRTUALLY DISAPPEAR, ALLOWING DOCTORS, IN EFFECT, TO WORK IN TWO PLACES AT ONCE. THE HOSPITAL'S OWN STORAGE AND RETRIEVAL SYSTEM, LINKED TO THE NETWORK, ALLOWS PHYSICIANS TO REVIEW THE SAME DATA FROM DIFFERENT LOCATIONS.*

- *BY COMBINING VIDEO, STILL PICTURES, VOICE AND TEXT INTO A SINGLE PACKAGE, TRANSMITTED IMAGES CAN BE AS SHARP AS THE ORIGINALS. RELATED PAPERWORK SUCH AS PATIENT FILES AND DIAGNOSTIC ANNOTATIONS CAN BE SENT WITH THE IMAGES, AND DOCTORS CAN EXAMINE AN IMAGE OR EVEN A WHOLE RECORD IN WHAT AMOUNTS TO A CONFERENCE CALL.*

- *TELEMEDICINE AND REMOTE DIAGNOSIS HOLDS SIGNIFICANT PROMISE FOR A CITY LIKE CAMDEN, NEW JERSEY. HEALTH CARE OFFICIALS IN CAMDEN CITE A LACK OF TRANSPORTATION TO HEALTH CARE FACILITIES AS A PRIMARY REASON FOR SOME DISTURBING FACTS. CAMDEN HAS ONE OF THE HIGHEST ADOLESCENT BIRTH RATES AMONG NEW JERSEY'S URBAN CENTERS YET IT RANKS AMONG THE TOP TEN MUNICIPALITIES IN INFANT MORTALITY. THIS IS LARGELY BECAUSE CAMDEN'S EXPECTANT MOTHERS ARE UNWILLING OR UNABLE TO OBTAIN NECESSARY PRENATAL CARE. CHILDREN WHO DO SURVIVE ARE OF LOW BIRTH WEIGHT AND RECEIVE LITTLE ROUTINE, PREVENTIVE MEDICAL CARE. TELEMEDICINE CAN ENHANCE ACCESS TO MEDICAL TREATMENT FOR THESE SEVERELY DISADVANTAGED MOTHERS AND THEIR CHILDREN, AND THE NEW FIBER OPTIC NETWORK WILL MAKE THIS A REALITY.*

- *A FIBER-BASED NETWORK COULD PARTNER WITH MOBILE MEDICAL UNITS TO BRING QUALITY HEALTH CARE TO CAMDEN'S UNDERSERVED POPULATION. SUCH UNITS CAN VISIT NEIGHBORHOODS REGULARLY TO PROVIDE BASIC AND PREVENTIVE CARE, AND ACUTE ILLNESS CARE AND FOLLOW-UP. THEY ALSO OFFER NEEDED HEALTH EDUCATION, SPECIAL SERVICES, INFORMATION, AND COUNSELING. FIBER TECHNOLOGY WILL ENHANCE THESE SERVICES BY PROVIDING INSTANT ACCESS TO MEDICAL HISTORIES AND TO DISTANT MEDICAL EXPERTS FOR CONSULTATION AND DIAGNOSIS. FIBER WILL MAKE REMOTE DIAGNOSTICS AND CONSULTATIONS POSSIBLE BY LINKING MOBILE UNITS WITH THE NETWORK AT PUBLIC ACCESS POINTS -- SCHOOLS AND COMMUNITY CENTERS.*

ONCE THE FIBER NETWORK IS EXTENDED TO THE HOMES OF ALL CITIZENS, ADDITIONAL AFFORDABLE EDUCATIONAL AND HEALTH CARE OPPORTUNITIES WILL EMERGE. INTERACTIVE EDUCATION AND HEALTH-IN-THE-HOME CAPABILITY WILL HAVE IMPORTANT APPLICATIONS FOR THE HANDICAPPED, HOME BOUND OR OLDER CITIZENS -- CITIZENS TODAY WHO ARE CUT OFF FROM MOST EDUCATION OPPORTUNITIES OR DEPRIVED OF ADEQUATE HEALTH CARE BECAUSE OF THEIR LACK OF MOBILITY.

- *THE THIRD APPLICATION I WILL DISCUSS IS ENTERTAINMENT.*

- *AS AN OUTCOME OF THE FCC'S VIDEO DIALTONE PROCEEDINGS AND NEW JERSEY'S ECONOMIC DEVELOPMENT INITIATIVES, WE ARE NOW AT THE FOREFRONT OF THE IMPLEMENTATION OF THIS NATIONAL POLICY. NEW JERSEY WILL ESSENTIALLY BE PIONEERING THE APPLICATION OF VIDEO DIALTONE. NEW JERSEY BELL HAS FILED ITS OPPORTUNITY NEW JERSEY PLAN TO MEET THE GOAL OF ENHANCING THE NETWORK AND ECONOMIC DEVELOPMENT. THE FIBER OPTIC SYSTEMS CURRENTLY CONTEMPLATED FOR VIDEO DIALTONE ARE A PART OF THIS INITIATIVE.*

- *THERE ARE CURRENTLY TWO APPLICATIONS SUBMITTED BY NEW JERSEY BELL BEFORE THE FCC TO PROVIDE VIDEO DIALTONE TYPE OF SERVICES IN NEW JERSEY.*

- *THESE ARE JUST THREE EXAMPLES OF POSITIVE BENEFITS THAT CAN RESULT FROM THE ADVANCED PUBLIC SWITCHED NETWORK IN NEW JERSEY. IT IS MY FIRM BELIEF THAT A NATIONAL NETWORK CAN REAP THE SAME BENEFITS AND ACCOMPLISH MANY OF THE ADMINISTRATION'S GOALS OF PROMOTING THE COMPETITIVENESS OF THE UNITED STATES IN THE GLOBAL ECONOMY OF THE 21ST CENTURY.*

- *I WOULD LIKE TO THANK THE SUB-COMMITTEE FOR THE OPPORTUNITY TO TESTIFY TODAY AND CLOSE BY SAYING THAT A MODERN, STATE-OF-THE-ART TELECOMMUNICATIONS INFRASTRUCTURE IS ESSENTIAL FOR THIS NATION TO REMAIN COMPETITIVE IN TODAY'S GLOBAL ECONOMY.*

- *THANK YOU.*

Resume

EDWARD H. SALMON

18 Porreca Drive
Millville, New Jersey 08360

(Home)609-825-3117
(Work)201-648-2013

PERSONAL: Wife, Marilyn. Son, James. Daughter and son-in-law, Kristine and Paul DiDonato. One grandchild, Joshua Paul.

EDUCATION:

1964 B.A., Liberal Arts, Gettysburg College
1971 M.A. + 30, Glassboro State College
1991 Ed.D., Educational Leadership, University of Delaware

PRESENT POSITION:

Chairman, NJ Board of Regulatory Commissioners
Member, Governor's Cabinet

PROFESSIONAL EXPERIENCE: 20 YEARS ELECTED OFFICE

NJ State Assemblyman, served as chairman of the Assembly Economic Growth Committee
Cumberland County Freeholder and Freeholder Director
Mayor, City of Millville
Commissioner, City of Millville, served as Director of Public Works
Chairman, South Jersey Federal Economic Development District
Vice President, Southern NJ Development Council
Committee Chairman, Southern NJ Technology Consortium

PROFESSIONAL EXPERIENCE: 27 YEARS IN EDUCATION

Teacher, Administrator, and Coach, City of Millville Public Schools

PAST & PRESENT CIVIC ACTIVITIES:

Former Trustee, Glassboro State College
Gubernatorial Appointee, 1979 County College Study Commission
President, Ocean City Masonic Club
President, southern NJ Boy Scout Council
Trustee, Ocean City Tabernacle Association
Instructor, Men's Bible Class, 1st Presbyterian Church of Millville
Board of Directors, Enrichment Center for the Blind & Visually Impaired
Volunteer: March of Dimes, United Fund, American Cancer Society, American Heart Association, NJ Youth Fitness Coalition

PROFESSIONAL ACHIEVEMENTS/HONORS:

86% win record as high school coach (basketball, track & cross country)
Twice named NJ Basketball Coach of the Year
Inductee, South Jersey Coaches Hall of Fame
1972 - 1 of 5 "Outstanding Young Men in NJ," NJ Jaycees
1973, 1981, 1991 - recognitions as "Outstanding Citizen of the Year"
Six recognitions as "Legislator of the Year"
Silver Beaver Award, Boy Scouts of America

Mr. VALENTINE. Thank you, sir.

Dr. Pepper?

Dr. PEPPER. Good morning. Thank you.

Mr. Chairman and members of the subcommittee, I'm delighted to be here today to testify on FCC initiatives to promote more rapid introduction of new communications technologies, and to provide a progress report on advanced television.

Nearly two years ago, the Commission held a hearing on networks of the future that led to several conclusions. First, users are indifferent to who provides their communications. Second, "the network" has been replaced by a growing interconnected web of multiple networks. Third, the advanced telecommunications infrastructure of the future will be heterogeneous, using a variety of technologies with different capacity and service characteristics.

Historically, government in a partnership with the private sector has played a critical role in developing our national communications infrastructure by setting goals, establishing a legal and regulatory framework, funding research and development and demonstration projects, buying service as the largest user, and, directly, by granting licenses to use radio spectrum.

It's important to remember, however, that government is necessary but not sufficient. Private industry is the engine that develops the new technologies, attracts the investment, builds the networks, and provides the services. Indeed, annual private investment in U.S. telecommunications infrastructure totals more than $50 billion a year, split evenly between network equipment and customer premises equipment. The net present worth of our investment in telecommunications infrastructure totals more than $400 billion.

Over the past several years, the FCC has embarked upon a number of proceedings designed to facilitate the deployment of new technologies and services and to foster competition, where little or none existed. Eight Commission proceedings stand out as examples: advanced television, emerging technologies allocation, personal communications services, video dialtone, mobile satellite services, digital audio radio services, local multi-point distribution services, and interactive video data service. My written statement addresses each of these, but I'd like to take a moment to give you a progress report on advanced television, or ATV.

Six years ago, when the FCC began its proceeding to adopt a new television standard, the focus was better pictures for broadcast television. Today, all of the remaining proponent systems are digital, and are committed to interoperability with non-broadcast media. And, based upon recent news accounts, Europe has abandoned its efforts to deploy its own analog system, and appears to be looking to the U.S. to develop a digital standard.

The Commission's Advisory Committee on Advanced Television Service met last month and issued a report stating that each proponent will be permitted to test improvements beginning on about May 1st. Once the testing is completed and the Advisory Committee makes its recommendation to the FCC, the FCC should be able to adopt a standard by late 1994.

At the same time, the Advisory Committee endorsed efforts by the remaining proponents to reach an agreement on a single uni-

fied system, also known as the "grand alliance." The new round of evaluation will incorporate additional interoperability tests and analyses. The Advisory Committee report found that, while the two interlaced systems tested better in the first round, "a transmission format based on progressive scan and square pixels is beneficial to creating a synergy between terrestrial ATV and national public information initiatives, services and applications." Therefore, each proponent will need to design and document a migration path that will result in a highly interoperable system, leading to progressive scanning and square pixels.

The U.S. electronics industry has redefined advanced television today as digital advanced television. If they succeed in incorporating characteristics permitting easy interoperability across media, we may end up adopting the basis for a global standard for high resolution imaging systems, as well as improving our domestic television industry and technology.

The FCC also is reforming rules which reflect outdated industry structures. As the President's technology policy paper noted, "Government regulations have tended to inhibit competition and delay deployment of new technology." We are aware of the conflict between the new realities and the old rules, and have been working to improve our regulatory processes.

Initiatives include requiring the largest local telephone carriers to interconnect with their local competitors; and we're also investigating changes in access to telephone numbers. The Commission also has sought to stimulate investment, by implementing incentive regulation and creating a pioneer's preference for technological innovators who need spectrum.

In closing, I would like to thank you for the opportunity to update you on FCC activities fostering new technologies and services. We'd be happy to work with the subcommittee, in any way, to further our shared goals. I would be happy to answer any questions that you might have. Thank you.

[The prepared statement of Dr. Pepper follows:]

Statement of

Robert Pepper
Chief, Office of Plans and Policy
Federal Communications Commission

Before the

Subcommittee on Technology, Environment, and Aviation
Committee on Science, Space and Technology
U.S. House of Representatives

on

National Technology Policy: Information Infrastructure

Tuesday, March 23, 1993

Good morning, Mr. Chairman and members of the Subcommittee. I am delighted to be here today to testify on FCC initiatives to promote the more rapid introduction of new communications technologies and to provide you a progress report on the Commission's process to set a transmission standard for advanced television.

As was stressed in the President Clinton's and Vice President Gore's recent technology policy paper, "Technology for America's Economic Growth, a New Direction to Build Strength," the nation's future economic and social well being will be affected by whether we can craft policies ensuring the rapid introduction of new and advanced communications technologies.

Nearly two years ago the Commission held an en banc hearing on "Networks of the Future." We heard from telecommunications users ranging from representatives of residential and disabled consumers, to public sector representatives from education and health care, to the very largest multinational corporate users. They all had the same message: they want to be able to communicate when and where they want to, at a level of capacity and quality matching their needs and at a competitive price commensurate with their service. They do not care who provides their communications -- telephone companies, cable TV operators, cellular operators, or anyone else -- as long as it meets their needs, is easy to use, is reliable, and is available at low cost.

What also became clear at that hearing is that we no longer have a single telecommunications system or network. Replacing "the network" is a growing interconnected web of multiple networks including private local area networks, traditional local public

switched networks,wireless networks including cellular, data networks, and long distance networks.

The advanced telecommunications infrastructure of the future will be broadband as well as narrowband. It will use closed network technologies such as copper wire pairs, coaxial cable and fiber optics but it also will use wireless radio transmission technologies. It will be stationary but it also will be portable and mobile. In other words, it will not be uniform nor provided by a single technology or industry. Rather, it will use different technologies and suppliers to meet the diverse needs of users.

The question for government policymakers is how best to facilitate the development and deployment of this heterogeneous advanced telecommunications infrastructure to meet the diverse needs of American society as we move into the 21st century.

Historically, government – in a partnership with the private sector – has played a critical role in the development and deployment of our national communications infrastructure. Government sets goals and established the legal and regulatory framework to ensure that the American people and American industry has the most advanced telecommunications infrastrucuture of any major indusurialized nation in the world. Universal service is one of these important goals.

Government also has provided funding for research and development and demonstration projects such as its support of the Arpanet that grew into what is known today as Internet. Moreover, as the largest user of the telecommunications infrastrucuture,

government has fostered the deployment and demonstration of new and advanced services.

One of the most direct ways in which the government affects the development and deployment of new and advanced communications technologies is by granting licenses to use radio spectrum. Many of the newest and most exciting communications technologies allow people to communicate from different places and while on the move. These wireless mobile and portable technologies need spectrum and the amount of spectrum allocated by the government for these services will directly influence the pace at which these services will be brought to market. The more spectrum the government makes available, the greater the incentives for innovation in wireless applications. As our society becomes more mobile, such innovation in the spectrum infrastructure is just as important as innovation in the wired infrastructure.

It is important to remember, however, that, while government plays a critical role in advancing our communications infrastructure, government is necessary but not sufficient. The private communications industry is the engine that develops the new technologies, attracts the investment, builds the networks and provides the services. Indeed, annual private investment in telecommunications infrastrucure in the United States totals more than $50 billion – split almost evenly between network equipment and customer premises equipment. Total net present worth of our investment in telecommunications totals more than $400 billion.

Over the past several years, the FCC has embarked upon a number of proceedings designed to facilitate the development and deployment of new technologies and services and

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to foster competition where little or none existed in the past.

Fostering New Technology

Eight Commission proceeding standout as examples of activity focused on developing and deploying new technologies: advanced television; emerging technologies allocation; personal communications services; video dialtone; mobile satellite services; digital audio radio services; local multi-point distribution service; and interactive video data service.

Advanced Television. Digital advanced television is one of the most important recent developments at the FCC that has the potential to transform the communications landscape. The dramatic progress in high resolution television systems technology over the past few years has increased the importance of the Commission's activities in this area.

Six years ago, when the FCC began its proceeding to adopt a new television standard, the focus was exclusively better pictures for broadcast television. And, while the public called this new television, high definition -- or HDTV -- the FCC chose to refer to it as advanced television -- ATV. The leading ATV system then was an analog system designed in Japan for satellite television transmissions.

Today, the Commission is overseeing a process that now includes representatives of alternative media (e.g., cable TV, satellites, packet networks) and the computer industry as well as broadcasters to come up with an advanced television system that potentially could become the basis for a global digital standard. All of the remaining proponent systems are

digital and all have committed to a flexible packetized data transport structure and universal headers/descriptors that will foster interoperability with non-broadcast media. And, based upon recent news accounts, the European Community has abandoned its efforts to deploy its own analog high definition television system and appears to be looking towards U.S. efforts to develop a digital standard.

The Commission's Advisory Committee on Advanced Television Service (ACATS) met last month and issued a report evaluating the comparative test results for each of the five candidate systems -- one analog and four digital. The report concluded that there are major advantages in the performance of the digital systems and, therefore, recommended that no further consideration be given to analog systems. The Advisory Committee also found that the four remaining digital ATV systems provide practical approaches that "lead the world in this technology."

The ACATS report went on to state that because each of the four systems would benefit significantly from further development each proponent would be authorized to implement improvements made since the last round of tests. Testing of those improvements is scheduled to begin by May 1st and take about five to six weeks for each system for a total of about six months. Once the testing is completed, the Advisory Committee will evaluate the results and make a recommendation to the FCC about the first of next year. That will be followed by four months of field tests. The Commission should be able to adopt a standard based upon the new tests by late 1994, about 18 months from now.

At the same time, the Advisory Committee endorsed efforts by the proponents of the

four remaining digital systems to reach an agreement that would seek the Advisory Committee's approval for a single unified system -- sometimes referred to as the "grand alliance." If the competing proponents can agree upon a unified system, they will be given time to build the improved system and testing likely will take place early next year.

Whether or not there is a "grand alliance" system, the new round of evaluation will incorporate additional interoperability tests or analyses. The Advisory Committee report found that while the two interlaced systems tested better in the first round, "a transmission format based on progressive scan and square pixels is beneficial to creating a synergy between terrestrial ATV and national public information initiatives, services and applications." Therefore, each proponent will need to design and document a migration path that will result in a highly interoperabile system based upon progressive scanning and square pixels.

The U.S. electronics industry has redefined advanced television technology as digital advanced television -- or DATV -- over the past three years. In doing so, they have changed the nature of the global debate about this new technology. If they succeed in incorporating characteristics permitting easy interoperability across media, we may end up adopting the basis for a global standard for high resolution imaging systems as well improving our domestic television technology.

Emerging Technologies Allocation. The FCC recently reallocated 220 MHz of spectrum in the 2 GHz band for emerging technologies such as personal communications services (PCS), wireless computer networks, and mobile satellite services. As noted earlier, spectrum is a critical element in the nation's telecommunications infrastructure. Better

management of this resource will reduce costs, promote innovation, and provide the public with a greater variety of services at lower prices.

Personal Communications Services. Personal Communications Services represent a new generation of wireless voice, data, and imaging applications. The rapid growth of cellular, cordless telephone, and paging services indicates that PCS could grow and develop into major new markets over the next decade. We estimate that authorization of PCS could result in investments of 15 to 45 billion dollars in new infrastructure. Already the Commission has granted more than 200 experimental licenses for these services. The Commission has sought comment on allocating between three to five licenses for a total of between 90 MHz - 220 MHz for PCS in 2 GHz frequency bands.

Video Dialtone. Within the past year, the Commission authorized local exchange telephone companies to offer video dialtone services which will permit them to transmit video programming for a wide range of competing service providers. One of the Commission's stated goals in authorizing video dialtone is to foster the development of an advanced telecommunications infrastructure. The other two goals are to encourage competition in the video marketplace and to enhance the diversity of video services. In the months since adopting the video dialtone Order, the Commission has received four applications by local telephone companies to offer video dialtone service and currently is evaluating those applications.

Mobile Satellite Service - LEOS little and big. Virtually all commercial communications satellites now in use operate from "geostationary" orbits some 25,000 miles

above the equator that allow them to remain in a fixed position over the earth. But there has been much interest recently in the use of low earth orbit satellites (LEOS) that operate in non-stationary orbits a few hundred miles above the earth. Because they are close to the earth, less power is needed for communications. Thus LEOS may be an economical way to provide communications services to lightweight mobile and handheld units in sparsely populated areas not covered by terrestrial facilities. It has been estimated that LEOS handheld units could cost only 25 to 30 percent as much as geostationary units.

The Commission has had requests for spectrum allocations for LEOS in two frequency ranges, the so-called "little" LEOS below 1 GHz and "big" LEOS above 1 GHz. Little LEOS would use a narrow band of spectrum for non-voice and low speed data, while big LEOS would use more spectrum for voice and data service. The Commission adopted an allocation and proposed technical rules for little LEOS in January of this year. The Commission also has proposed a big LEOS allocation above 1 GHz. A negotiated rulemaking committee has been convened with the six big LEOS applicants to develop spectrum sharing rules.

Digital Audio Radio Services (DARS). Digital technology offers the promise of audio broadcasting equal in quality to the compact disc and satellite DARS holds the potential for unbroken coverage over large contiguous areas. The Commission last October proposed a spectrum allocation for satellite DARS and asked for comments on technical and regulatory issues of both terrestrial and satellite systems. License applications have also been accepted from six firms proposing satellite DARS systems. The Commission also is examining terrestrial DARS to be implemented within currently allocated broadcasting spectrum (AM

and FM bands).

Local Multi-point Distribution Service. The Commission initiated a rulemaking this year to allocate 2 GHz of spectrum in the 28 GHz frequency band (27.5 GHz - 29.5 GHz) for local multi-point distribution service. The proposals include licensing two carriers in each geographic area with one gigahertz of spectrum each. While it is expected that many licensees will initially offer wireless video services, the rulemaking leaves technical parameters as flexible as possible in order to promote innovation and the development of competitive wireless service applications.

Interactive Video and Data Service. Last year the Commission established a new personal radio service called interactive video and data service (IVDS) which promises to bring interactive television services to consumers. Approximately 4,100 IVDS applications have been filed to the Commission, although licenses have yet to be granted.

Regulatory Reform Initiatives

In addition to authorizing new services, the FCC is changing old rules to better conform to the new technological and market realities. The Commission is reforming its rules to foster competition and to provide additional incentives to attract investment in the communications infrastructure.

Many of our old rules reflect out-dated industry structures. Boundaries that separated industries in the past are rapidly eroding. Many of our old rules maintain barriers to full

service deployment by all potential players and, therefore, reduce incentives to invest. As the President's technology policy paper noted, "regulatory policy can have a significant impact on the rate of technology development. . ." and that "government regulations have tended to inhibit competition and delay deployment of new technology." At the FCC, we are aware of the conflict between the new realities and the old rules and have been working to reform our regulatory processes to promote competition and spur investment in new technology.

Initiatives designed to foster competition include requiring the largest local telephone carriers to interconnect with their local competitors and investigating whether access to telephone numbers needs to be reformed. The Commission also has reformed its regulatory processes to attract investment in communications technology and services by implementing incentive regulation and creating a pioneer's preference for technological innovators who need spectrum to start a new service. The Commission also has created a formal process to ensure the continued reliability of our telecommunications networks as new and competing technologies and services are deployed.

Interstate Access Interconnection. The FCC has recently required that the largest local exchange telephone companies provide expanded interconnection (for interstate special access) to competitive access providers, long distance carriers, and end users. This was an important step in opening up the local exchange carrier (LEC) networks to additional competition. It is likely to speed the deployment of new network technology and provide users with facilities that better meet their needs, both by giving them the choice of additional facility providers and by spurring the LECs to improve their networks in response to competition. The Commission has also proposed to extend the expanded interconnection requirements to

switched access.

North American Numbering Plan. A potential barrier to the rapid adoption of new communications services such as PCS is the limited supply of telephone numbers under the North American Numbering Plan. The numbering plan is currently administered by Bellcore which is owned by local exchange telephone companies. Bellcore may face a conflict of interest in assigning numbers to providers of new services that may compete with those provided by its owners. Thus in October 1992 the Commission issued a Notice of Inquiry asking for comment on who should administer the North American Numbering Plan and what criteria should be used for assigning new telephone numbers.

Price Cap Regulation. The Commission has replaced rate of return regulation with price cap regulation for AT&T and LECs' interstate services. Under rate of return regulation carriers had an incentive to excessively expand the rate base in order to increase their profits. Price caps removes this distortion and is likely to result in a more efficient infrastructure. In fact, according to a recent study, AT&T has dramatically increased its network investment since the introduction of price caps.

Pioneer's Preference. The Commission has implemented a new procedure to reward innovators of new radio services and technologies with the guarantee of a license. In the past when the Commission reallocated spectrum to a new service, the entity that developed the new service or technology was given no preference when awarding licenses for that service. By providing "pioneer's preferences" the Commission hopes to spur greater innovation in spectrum-using services and technologies. As I noted before, such innovation in the spectrum

infrastructure is just as important as innovation in the wired infrastructure.

Network Reliability. One of the Commission's important responsibilities as we foster new services and technologies is to ensure that our existing telecommunications networks continue to be the best in the world. To this end, the Commission has taken several steps to insure the reliable operation of our public networks. Beginning in 1991, the Commission established an internal quick-response team of specialists to monitor and investigate outages, and make recommendations for changes in industry practices. In addition, the Network Reliability Council (NRC) was created as a forum for carriers, manufacturers, state regulators, and users to address network reliability concerns. As a result of Commission efforts, carriers now must report the details of any major outages to the Commission within 24 hours. The NRC has also conducted several studies on key network reliability factors such as SS7 signaling networks, fiber optic cable cuts, power failures, fires, and 911 outages.

In closing, I would like to thank the Chairman and the Subcommittee for the opportunity to update you on the FCC's activities designed to foster the development and deployment of new telecommunications technologies and services. These issues are important for the nation and its well being as we enter the 21st century and it is exciting for us who have been working on these questions to see the growing recognition of their importance. We would be happy to work with the Subcommittee in any way to further our shared goals.

Thank you. Now, I would be happy to answer any questions you may have.

Mr. VALENTINE. Thank you, Dr. Pepper.

Dr. Salmon, your testimony refers to New Jersey Bell's plan to accelerate the deployment of advanced switching and transmission technologies over the next 17 years in order to have a digital fiber broadband network by the year 2010, I believe you said.

Dr. SALMON. That's correct.

Mr. VALENTINE. Does the plan prioritize the deployment by, for example, first targeting health care and education, and consumer and home entertainment last, or is the reverse true? Or is deployment dictated by other criteria?

Dr. SALMON. The plan has base four fundamental service capabilities. The first is advanced intelligent network, sort of like follow-me-type service, which will be 100 percent employed by 1998. The second is a narrowband digital service. It's 144,000 bits per second, which will have 100 percent employment also by 1998, and it's sort of like a pipe. What can go through that pipe is going to be expanded to be wider and wider, until it's unlimited. That's the potential that fiber optics has, and then it will go to a wideband digital service which has a 1.5 megabit—that's 1,500,000 bits per second of information through transmission and digital. It starts in 1994, 95 percent employed in the state by 2000. And eventually, you build on that, like you build on roads, and you'll build up the broad band digital service which is 45 megabits, and that is 45 million bits per second, and that will start in 1996 to be employed in the state, 35 percent completion by 2000 and 100 percent completion by the year 2010.

The services will be offered, and on a competitive basis, service will go on the network as the technology is made available to a variety of companies that would want to go on that network. There is no direction that says, by this year, all the educational services will be on; by this year, all the health services will be on. Basically, you're going to provide the network, and as these dates come available, and the technology is in place, and the network is there, then you're going to have a variety of service providers coming on that network on a competitive basis to go out and fight for that customer. We think competition is the key to that, making that network successful, and that everyone's on an equal basis competing for that customer.

I don't know if that answered your question. That was a long answer, but I wanted to try to give you how we put the network in place first and then the others come—will naturally follow. It's a natural progression. But without the network, the others can't follow.

Mr. VALENTINE. In your statement you refer to the introduction of price cap regulation. Is the pricing structure of the Internet feasible for a commercial data network, in your opinion?

Dr. SALMON. Yes. That's my shortest answer.

[Laughter.]

Mr. VALENTINE. Well, that's very strange to hear a straight-out "yes" or even "no" around here. Are you sure? Never mind.

[Laughter.]

I have just another question or two before I ask Dr. Pepper one or two short ones. And let me see if I can understand the business of financing this arrangement. You mentioned the fact that it

makes sense that it would be manifestly unfair if those who paid the bill for the use of the services of New Jersey Bell had that company go to the regulatory commission in your state, and ask for a rate increase to pay for this, which some suggest they would certainly do if they weren't barred or prohibited.

Does this mean that there will, of necessity, be an extensive amount of risk capital expended by New Jersey Bell, or whence comes the financing?

Dr. SALMON. I think the answer is yes, there will be. New Jersey Bell is, by having regulatory certainties in place, New Jersey Bell is making a major investment. As you noted in my comments, Mr. Chairman, basic residential rates are frozen. It might be interesting for you and the other members of the committee to realize that the original plan called for basic residential rates to be frozen to 1995, and then there could be increases based on the CPI as each year went, through to 1999, at the end of the plan.

I would tell you, this is a very complex Opportunity New Jersey proposal that was before this commission. And, as you can note if you just take fifteen and a half days of technical testimony from key witnesses throughout the country coming in to testify, we made a lot of modifications to the plan. What New Jersey Bell originally proposed is, in concept, basically there, but there were a lot of modifications. And one of those modifications, where we have the lowest basic residential rates in the country now, we're one of the lowest, and we wanted to freeze that rate through the length of the plan, and the plan really would be funded in four areas, and I think this comes to the crux of your question, Mr. Chairman: how is the plan going to be funded by the company?

One is: 44 percent is going to be lower dividends. About 20 percent is retained earnings. Debt issuance is about 25 percent, and around 13-plus percent will be new services, in other words, new services that will be provided that will bring in additional revenue. So those are the four basic areas: retained earnings, lower dividends, new services, and new debt that is going to go forward to financing Opportunity New Jersey.

Mr. VALENTINE. Thank you, sir.

Dr. Pepper, what—when many of the media, many in the media talk or write about the National Information Infrastructure, they focus on fiber and coaxial cable to the home. However, a lot of R&D is going on in wireless and mobile technologies. Do you believe that it's important to consider wireless technologies, wireless technologies in the context of the National Information Infrastructure?

Dr. PEPPER. Yes, absolutely. Wireless technology provides some of the best opportunities for extending access to new services. The American society is becoming increasingly mobile. We're on the move. So new technologies that will permit portable and mobile services, access to high bandwidth as well as narrow bandwidth services using wireless technologies will make a major contribution to our infrastructure—and there are recent developments coming out of the laboratories, new developments coming out in terms of product development—that are today leading to new wireless services. So wireless, we see wireless as a very, very important component of our national telecommunications infrastructure.

Mr. VALENTINE. Since—well, first of all, let me say in your statement you referred—you say, "The remaining advanced television proponents will need to design and document a migration path," and so on and so on. Since two of the systems are interlaced, so-called interlaced systems, could you explain in a little more detail, for the subcommittee, what you mean by designing and documenting a migration path?

Dr. PEPPER. The Advisory Committee, in its report, adopted on February 24th, found that although the interlaced systems tested better in the initial round of testing, the benefits of progressive scan and square pixels were that they would fit better with alternative media, especially computer applications. Therefore, in the long run, the Advisory Committee saw that we will need a progressive scan, square pixel advanced television system, but it also recognized that at least initially two of the proponents—and, in fact, at some point perhaps all of them—might want to use interlaced equipment for generating images production. So, therefore, the Advisory Committee suggested and recommended very strongly that the proponents, whether they begin with interlaced or they would begin with a progressive system, would provide a migration path to ultimately achieve a progressive scan, square pixel system.

What that will mean for the interlaced proponents is that they will need to develop a technical process by which, even if they start with their interlaced system, it can, over time, evolve into or be used with a progressive scan system. It's interesting to note that when President Clinton and Vice President Gore were visiting Silicon Graphics a couple of weeks ago out in California, that there was somebody following them around from Silicon Graphics with a little camcorder, and yet that camcorder was originating—I honestly don't know; I believe it was an interlaced image, but it was being displayed on all the workstations at Silicon Graphics which are progressive scan, square pixel computer display devices. So there is the ability technically to translate from an interlaced to a progressive system, and what the Advisory Committee recommended was that all of the proponents develop a migration path, a way ultimately to end up with what they believe is most compatible with the national information infrastructures.

Mr. VALENTINE. Thank you, Dr. Pepper.

The gentleman from Maryland, Dr. Bartlett.

Mr. BARTLETT. Thank you very much.

Dr. Salmon, you mentioned in your discussion of what the telephone company is doing in New Jersey that one of the possible uses of the new information infrastructure would be home entertainment. This, quite obviously, puts the telephone company in what I think is a very desirable position of being in competition with cable TV.

Do you support other competitions between cable TV and the telephone company?

Dr. SALMON. I think if you follow what's been occurring around the country, that there are cable television and local telephone companies in competition with each other. They are also in some joint ventures together, and you're seeing cable companies getting into telephone service and you're seeing the telephone companies looking now to get into providing home entertainment.

So, you know, I believe as you go through the future and you create a level playing field, that the more you can increase competition, not only is it going to be better for the consumer, but I think it's going to be better for the Nation. So I think as a board of regulatory commissioners, our responsibility is to try to create that competition and make sure that everyone will have an opportunity on that network.

Mr. BARTLETT. Thank you. Understanding that competition has been the thing that has made services and products better, cheaper, and more accessible, I think that almost everyone applauds this. Do you think that as this competition develops that the Government can—and becomes really a viable competition—that the Government can gradually withdraw from some of its regulatory functions?

Dr. SALMON. Yes.

Mr. BARTLETT. Great. That is—

Dr. SALMON. But let me just—let me just make one point. And I think—you always have to have the safeguards in place, but I think you can lessen the amount of regulatory obstacles that are there that do not help promote competition.

Mr. BARTLETT. That's right and that's a tough thing for a bureaucracy to do. Bureaucracies rarely want to get smaller; they usually want to get bigger, and I'm not sure how we can be vigilant enough to make sure that they get smaller as competition develops.

In New Jersey, it was the telephone company that made the financial investments in this system?

Dr. SALMON. Yes, New Jersey Bell.

Mr. BARTLETT. Okay. Do you recommend this as a model for the country rather than having the government providing venture capital and picking winners and losers?

Dr. SALMON. Yes.

Mr. BARTLETT. Great. You have all the right answers this morning.

[Laughter.]

Dr. Pepper, we have been talking largely about a wired kind of a National Information Infrastructure. Obviously, "wireless" has been developing very rapidly. Do you see the possibility of competition between the fiber optics and wireless, including satellites, and so forth, so that we can have really a viable competition nationwide?

Dr. PEPPER. Yes, for most services, and I believe that some of the newest wireless technologies, in fact, could provide two-way broadband access into the home and to areas that are low density. We currently are looking at a service that we refer to as a multipoint, a local multi-point distribution service, which is at 28 gigahertz, which conceivably could be a wireless broadband link into the home, which could significantly reduce the costs of broadband to the home.

Mr. BARTLETT. We just recently celebrated Abraham Lincoln's birthday. I think he said something to the effect that government should only do for its citizens what they cannot do for themselves, and I would hope that as competition develops in both of these areas that we can move closer to the vision I think that Abraham Lincoln had for the role of government.

Thank you both very much. Mr. Chairman—

Mr. VALENTINE. Thank you, sir.

Before I recognize the distinguished gentleman from New Jersey, Mr. Klein, let me just say to Dr. Salmon, you have violated the rules of the committee, subcommittee, now three times by answering a question with a simple "yes" or "no."

[Laughter.]

So it's my duty as chairman to caution the gentleman.

[Laughter.]

Mr. KLEIN. Well, Mr. Chairman, that's the way we train them. We grow them up that way in New Jersey.

[Laughter.]

Dr. Salmon, you have articulated very, very well the advantages in developing an information infrastructure, the information superhighway, but there's another aspect to this, is there not? One of the main concerns—indeed, perhaps the main concern of this committee, in my mind—has been the task of encouraging the development and creation of new jobs and high-paying jobs. I think we've seen in the last dozen years the dwindling of our industrial base, the loss of good, high-paying industrial jobs. Do you see this industry, and the development of the information superhighway, as a means, first of all, for New Jersey to obtain new high-paying jobs? And, secondly, if the concept, not necessarily this specific model, but the concept, of expanding the information highway nationally, do you see that as a means for the nation to create new high-paying jobs?

Dr. SALMON. The answer is yes, yes, but I'm not going to violate the chairman's order or rules, and let me just tell you a little particularly, why I say yes and yes.

First of all, I think the future of America, as we move into the 21st century, is going to be which country, and which states, have positioned themselves to be able to be on this information highway, and have the technology and the infrastructure to be able to move forward in attracting industry and business and high-tech paying jobs into the state and into the nation. As I indicated to you earlier, we're in a global economy, and the competition that we're facing is going to depend on how we position ourselves as America, and I think that's your responsibility, and I think that's why you're moving forward, to try to move with the administration, to make sure that we are in that position as a country, and that we are the best.

In New Jersey, in particular, the construction jobs for the infrastructure are anywhere from 3,500 to 4,000 that will be created. But, more importantly, when the network is in place, we will be looking at over 24,000 permanent jobs that will come to the State of New Jersey. And then you have to look at the ripple effect, and what kind of industries and businesses are created by that infrastructure.

And I think the most important thing I could say about jobs, and looking forward to the 21st century, to you, as members of this committee, is that as we try to attract the right high-tech industry and business into New Jersey or into America, you're going to have to have the telecommunications needs—you're going to have to be able to meet their telecommunications needs, in order to be a part of the global economy, and that's really where we're at.

Mr. KLEIN. Thank you.

Isn't there also still another benefit in terms of jobs? And I'm thinking specifically of the—you mentioned the fact that New Jersey would be five years ahead of Japan in establishing a full information superhighway. Whether it be Japan or whatever other country, would the fact that the United States has the lead in developing the information technology, and the information superhighway, give it an opportunity to sell products and services in the industry itself to other parts of the world, as other nations that may be behind us in the development of this technology seek to take advantage of our competitive abilities?

Dr. SALMON. I'm afraid to say this, but the answer is yes.

[Laughter.]

Mr. KLEIN. Let me let you go ahead and—

Dr. SALMON. Let me just clarify that. We have Bellcore and Bell Labs in the State of New Jersey, which are your major research industries for telecommunication. AT&T's corporate headquarters is in the State of New Jersey. So New Jersey's always been positioned as a leader in the telecommunication field, because of the smallness of the state, and the amount of people that are there, 8 million people in that size of a state, and then the fact of what's located in the state.

You're having in the country today a lot of expertise that's being sold, and products that's being sold in the area of electricity all across the world. In the same way, I think you can say that's going to happen in telecommunications. If we position ourself right as a nation, we could be the leader that will connect the world, and I think that can happen. And if that does happen, that certainly, as you said, Congressman Klein, is going to lead to a lot of job creation.

Mr. KLEIN. Thank you.

Was any consideration given in your study to the concerns of many, regarding the issue of cross-subsidization?

Dr. SALMON. If you would read the testimony, for the fifteen and a half days that we took testimony from the expert witnesses throughout the country, this was one of the major concerns. And this was a major concern of the board, that there not be cross-subsidization.

We have in the plan three cost studies: the incremental, embedded, and fully distributed cost studies. The board also has the option at any time, because we really have control of the plan, in regard to requiring separate subsidiaries.

As I mentioned, there were 13 intervenors in the plan, and, as I also mentioned, there were quite a number of active players from throughout the area, New York and Washington, different law firms that came up to be a part of this historic record. One of those intervenors was the Press Association. The Press Association, a very active intervenor, a number of editorials opposing the plan were in the papers throughout the state, and I'm very pleased to announce today that one of the things we did from the bench was direct the Press Association and New Jersey Bell to work together to create a competitive field, which will be beneficial to both. And It's my understanding that today, they are going to announce an

agreement and that they have worked out an amicable settlement and probably will make that part of the board order.

Mr. KLEIN. Well, I have just one other question, and it's somewhat related to the last one. And that is, in addition to the Press Association, there are others who obviously have an interest in the whole information industry. We find—I have found, that people in the cable TV industry, and in the broadcast TV industry, in the cellular telephone industry have all expressed concern that New Jersey Bell, or anyone positioned like New Jersey Bell, might have a competitive advantage over others that would have a very legitimate interest in utilizing the information superhighway.

Could you address that, and specifically tell us what, if anything, you have done, your agency has done, to address the very legitimate concerns of those other interested parties?

Dr. SALMON. That's a good question because, as you look forward to the future of telecommunication, you see all the players that the Congressman mentioned are very important players, and are going to be a very important part, as we go to the 21st century, whether you see wire, whether you see wireless, whether you see the cable TV, whether you see computers. You can go on and on with it, with the different industries and businesses that are out there, and the technology that's going to become available. It's important that they all have equal opportunity and access to the services. That's why we have ordered the services to be unbundled and that they be fair and open to everyone. I think you're going to see, as a result of the way you put a plan together, that you give everybody an opportunity, and you enhance competition by giving everyone an opportunity, and that's certainly the direction you want to go.

Mr. KLEIN. Well, Mr. Chairman, I really think we ought to congratulate both of these distinguished witnesses, and it seems to me that they have laid out a role model that gives this committee great opportunities and great encouragement. Thank you very much.

Mr. VALENTINE. Thank you, sir.

The gentleman from California, Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you. And I would join my colleague in praising our panelists, and I've learned a lot here today.

Just a little historical note, as I remember that early on in our country's history there was a national debate over internal improvements, and I believe that eventually the people who won out were people who believed that there should be a major canal system built in our country. And, as a matter of fact, the remnants of that canal system are right down here in Georgetown.

[Laughter.]

And for those who really understand what happened to that, it was that we invested an enormous amount of money in a canal system, a specific system. And just as it was finished, the railroad technology was coming in and all the states that really invested in it went broke and they were actually—the canal system did more to impede American progress than any investment this country ever made. But at the time the decision was made, it was the ultimate technology in moving goods and services.

I just want to make sure that, as we move forward, that we don't make that same kind of mistake. Instead of a canal system, our

forefathers and mothers should have been talking about a transportation system and how to make sure that it was an inclusive transportation system that worked together with the new ideas that were coming up, rather than just forcing a canal system on us. I think—the State of Illinois I think wasn't out of debt until 1910, I believe, from their canals which didn't help them very much.

I'd like to know, first of all, what—in New Jersey, for example, is there any inclusion of the power companies? I know there's been a lot of technology and development in the area. Maybe electric lines, or something like that, are using what they've got to help in this type of system. Is there any—I just don't know. What would be done in New Jersey on this end?

Dr. SALMON. I hope the chairman doesn't get mad at me, but the answer is no.

Mr. ROHRABACHER. No?

[Laughter.]

Is there any—and maybe I could ask Mr. Pepper—is there any potential there? I mean, I just—someone was telling me that perhaps the power companies are one group of people in our society that have been left out of this whole arena?

Dr. PEPPER. Yes, that's a very good question. There was a recent study published by the Progressive Policy Institute that looked at the role of the electric utilities in the information infrastructure, and they concluded, in that study, that there's an appropriate role. In fact, you could look at it as the electric utilities becoming an anchor tenant in a telecommunications network provided by telecommunications providers, phone companies.

We have a—in one of our proceedings we've been looking at using spectrum currently occupied and used by electric utilities for new personal communication services, and the utilities have now come back to us and said that they would be interested in perhaps using some of that spectrum as well to provide similar kinds of services.

Electric utilities have billing and collection systems. They have wires. Some of them have even run parallel fiber networks alongside their electric lines. I think that there is a role to play. The fact is, the utilities are becoming increasingly communication companies, but at the moment, more for their own internal communications. In the future, there certainly is a possibility for them to become part of the mix in more public types of communications networks.

Mr. ROHRABACHER. I—another historical note, Mr. Chairman, and that is that we are going through a great change in our country right now. It's we are going from the cold war into the post-cold war era. I come from California where that transition is most difficult, but I am extremely confident that as we shift some of our best minds out of producing weapons that explode and kill people, and which were necessary to deter war in the last 40 years, into freeing them to focus on things like just what we're talking about today, that there are going to be options in front of us five years from now that we can't even imagine, and whether it's the electric companies or—I had a gentleman come into my office, for example, who was very much involved in the development of the global positioning satellite system which was designed originally to help us guide our missiles and airplanes to their targets. And he isn't

spending his time doing that anymore, and he's spending his time now developing cellular telephone technology that can be used from satellites.

And I would believe that in the future there's even—there's a great—I mean, he opened my mind to the potential of cellular telephones, just based on bouncing off satellites. And I would hope that as we move forward—and this has been expressed several times by both of the witnesses—that we do make sure that we are not, in making sure that we're fostering cooperation and trying to set down a plan, that the plan is an inclusionary plan for things that we don't even know about today.

And I want to congratulate both of the witnesses, and maybe if you have anything to comment on that last statement, go right ahead.

Dr. SALMON. Well, I think you state it very well, Congressman. I think as a regulator that you have to make sure that you have three characteristics. One, you have to be open-minded because things change so quickly. I mean, I have seen so many changes in just the two years that I have been on this board, and you find out that if you're not open-minded, that you're not going to learn, and you're not going to change if technology changes. Two, you have to be flexible, and, three, you have to be looking at how you can promote competition. The more you can do to promote competition, the better it's going to be in the long run.

I had an opportunity, because of my position, to view a number of videos that have been put out by different people in the industry, the show about the world of the future. And when you look at this world of the future—and I always thought of the future like 10, 20 years from now; you're only talking three, four, or five years from now—it's just mind-boggling. And I'm sure you and your committee have been attuned to some of the similar videos. I mean, it's going to be—it's a great time to live, and there's great challenges out there, and I think your subcommittee is going to play a major role in the future of America, just with your directions in moving forward with the administration on the plans for the new technologies.

Dr. PEPPER. In fact, Congressman, a good example of what you're talking about is what occurred at a meeting a little over three years ago when some of the most knowledgeable, what I'll refer to as, analog engineers said that a digital advanced television system in six megahertz would defy the laws of physics. Well, in fact, that's not the case. In fact, five or six months after that, some people who had been working in the defense community, who are now applying their skills to civilian problems and technologies, came out with and developed the digital advanced television system.

I think that the role for government is to set goals, focus attention in setting those goals, to foster investment, but to be technology-neutral because we don't know in advance what the specific technologies will be that will meet the objectives that we're setting. And I think that it's entirely appropriate to have a goal for advanced telecommunications networks and services that can accommodate broadband transmissions as well as narrowband transmissions, but recognize that we're going to have a heterogeneous

network and a heterogeneous set of technologies to provide those services.

And I think that it's the industry and the technologists within the industry, the engineers in the industry, who will be developing the specific applications to meet those goals.

Mr. ROHRABACHER. Well, let me note that it was a fellow named Gil Hyatt who, I think it was about 30 years ago now, first pioneered the microcomputer, and it took him a long time for him to get his recognition. In fact, it was the Patent Office that didn't give him his patent, I think, until three or four years ago. And Mr. Hyatt has been working on liquid crystal technology and has developed a—and there's been a major breakthrough that he claims he has developed in liquid crystal technology. That would permit us, again, to have such incredible options without the—and in the past when we talked about technology, we talked about altering the environment and we had all sorts of—in television sets, we had all sorts of things left over and we were talking about television—telephone communications. We were using huge amounts of copper cable across the Atlantic. And with these new advances that we're talking about, we will be able to accomplish so many things, without damaging our environment at the same time. I find that to be just as exciting as any other aspect of this.

So thank you very much, Mr. Chairman.

Mr. VALENTINE. Well, I thank the gentleman from California for his contribution always. You know, maybe we should think about the fact that when they started digging all those canals the labor was so grueling that that set the imagination of smart people, of which New Jersey has so many, and they figured out the railroads.

[Laughter.]

I've got some more thoughts, but I don't want to take any time away from Mr. Coppersmith from Arizona, except to say that you guys better start, as everything becomes digital, the scientific community will have a responsibility to replace the terms "clockwise" and "counterclockwise."

[Laughter.]

The gentleman from Arizona.

Mr. COPPERSMITH. Thank you, Mr. Chairman, although I guess that means I'll never know which way I'm going.

[Laughter.]

Mr. VALENTINE. You'll figure it out.

Mr. COPPERSMITH. I hope so.

Speaking of which, I think mine just went off, so I need to be brief.

Dr. Salmon, having been through this ratemaking and rate-structuring process, what advice would you have for public utility commissioners in other states, as they look at these issues, as far as how they should approach them with their utilities, what kind of proactive steps they could take or what sorts of things the industry itself should be presenting to the commissions in the various states?

Dr. SALMON. I think the key answer to that question, Congressman, is, do they, by legislation, have the ability to have an alternative form of regulation in the telecommunication industry? If you do not have that alternative method to regulate, then there's noth-

ing they can do. So the legislature and the governor of that state would have to make a priority that they wanted to move into the 21st century, and put that legislation in place. Once that legislation is in place, I think the next advice I would give to them—I think this is such an important issue that we as a board made the decision to hear the case, so that we could go through every issue and do it step by step, instead of sending it to the administrative law judge to hear. And I think because of the importance of the issue before each and every state, I would give that recommendation to them.

Mr. COPPERSMITH. Is the best way to do that through the national association, or do you think that the FCC should play a role in suggesting ways that states could change their structure for those states that may not have the ability, the legal ability yet, to do innovative ratemaking?

Dr. SALMON. I think you could go both; both routes would be fine.

Mr. COPPERSMITH. Thank you. Thank you very much, Mr. Chairman.

Mr. VALENTINE. I thank the gentleman.

Let me say, briefly, in conclusion, that—to kind of follow up on what has been suggested by some of the questions—this is, indeed, an exciting time. And I think that if we work together, the government not only here, but the governments in the 50 states, to make the most of the opportunity that is on the near horizon, because this country has—and I think we ought to remind ourselves of this—when we have been—we have been fighting the cold war. We have been expending the money to build up the military force to defend all of the industrial powers, our former enemies, and we have in many ways kept our own, maintained our position. In some ways, in many ways, we've fallen behind in the competitive race. In many ways, we have inched ahead. What we should be able to accomplish in this country if we could put to use for these peaceful purposes, in building up the competitiveness of our country to what it used to be, with the money that we have had to defend—had to spend defending everybody else.

I also want to add my words of congratulations. I have made notes to myself to have this testimony of both of you gentlemen summarized to send to Governor Hunt in North Carolina to say, "Lookie, lookie."

[Laughter.]

Because the federal government can be a part of—well, can not only be a part of, but the main force behind, as it was, the interstate highway system. And the interstate highway system was successful, brought all the states in this union together, because it was one initiative that it was impossible to exclude anybody. You couldn't have an interstate highway system that moved from New Jersey to California without affecting all the states in between.

And if we—in states like mine and many others, I think we have made considerable progress in these areas, North Carolina more so than most people would realize. But unless we are able to emulate what you've done in New Jersey, we're going to find ourselves perhaps with a great interstate highway system that brings the goods, wares, and merchandise of the nation to the boundaries of a state and moves from there on dirt roads.

Finally, could you in a word or two tell us, either one or both of you, what the federal government should really be about in this situation: further initiatives or get the hell out of the way?

Dr. PEPPER. I think there clearly is a role for the federal government. Part of it is getting out of the way, but getting out of the way means modifying some of the rules that we have, that have created artificial boundaries around old industries. These artificial boundaries keep potentially competing players bound up, and they can't cross that line.

So, for example, there are barriers to the cable television industry entering the telecommunications business. There is potentially a very vigorous player there to add to our infrastructure. Likewise, there are significant boundaries to local telephone companies getting into the delivery of video services. Those boundaries need to be broken down. They should be broken down in both directions.

I think it's, as I mentioned earlier, very important for the federal government to set goals; to focus on what our goals ought to be; to set the legal and regulatory framework; to fund research and development; to fund testbeds, trials and demonstration projects. Sometimes you have to show, or prove, that things can be done before they get to be done. It's a chicken-and-egg issue. But that doesn't require a lot of dollars; it requires some innovative thinking.

I mean, the ARPANET which developed into the Internet was a federally funded program out of the Defense Department, and it's turned out to be enormously successful. The early packet switching technology, that is now used on a commercial basis worldwide, came out of some very early government-sponsored R&D dollars.

Through procurement, the government is the largest user of our telecommunications infrastructure. Through coordinated and effective procurement policies by government, the government can provide incentives for private investment in advanced networks with increased capacity and increased functionality.

And then for the FCC, we grant licenses to people who want to use radio spectrum. And the fact is, some of the most exciting new services, as I mentioned, are in this wireless area. They can't operate, they can't even get off the ground and get started unless they get licenses. So we need to work better and reform our licensing process; get spectrum, and make it available to the private sector, so that people can develop these new technologies.

So there's a whole role of activities that are entirely appropriate—in fact, I would argue needed—by the federal government.

Mr. VALENTINE. That don't cost any money.

Dr. PEPPER. That don't cost any money. Already, the private sector is investing, as I mentioned, more than $50 billion a year in this sector. That's a lot of money. And if we can harness that and focus it, I don't believe the government needs to spend a whole lot of money beyond that, but rather give a little bit more structure and/or reduce the barriers to the current players, so that they can make investments and start competing and developing new services.

Dr. SALMON. I would just add, Mr. Chairman, that Dr. Pepper has listed a number of things that are right on target. I want to conclude, if I can, by thanking you again, and also Congressman

Klein, for the invitation to be here, because I think we all need to be sharing what can be done and what direction we can move in.

And I want to conclude also with just a thought, if I may, and it reminded me of your dirt road in North Carolina. And the fact that as we move into this 21st century and we see the changing world and the changing technology and everything that's going on, and we want the United States to be the leader. It reminds me of the story of the golfer who happened to hit a bad shot and it landed into a sand pit and it landed right beside a colony of ants. And there were 99,999 ants in that colony. And this was not a very good golfer, by the way. He was sort of like me, and he took his first swing and missed the ball and it went right through the colony of ants and killed 99,000 ants on one swing.

The second swing did the same thing and this time it killed 900. And on the third swing he killed 97. Finally, there's only two ants left. And one ant looks at the other ant and says, "You know, if we're going to survive, we'd better get on the ball."

[Laughter.]

Mr. VALENTINE. Well, there's no way the subcommittee can punish a guy that will tell a story like that. Very good.

[Laughter.]

One parting shot: is there any organized national exchange of ideas amongst these regulatory agencies such as yours, which would serve as a means of letting your compatriots in other places know what is happening in New Jersey?

Dr. SALMON. That's a very—that's a very good question, and there is. There's a National Association of Regulatory Utility Commissioners. It's with all 50 states' commissioners. We meet for summer meetings on the west coast. We meet for our annual winter meetings right here in Washington, D.C., and then we have our annual conference somewhere around the country. So there's three times minimum that all the commissioners are together to exchange ideas and look at direction.

I think this is an organization which it's important for the regulators to be very active in, and also important as an organization to make views much clearer to you here on the Hill and to the administration, because I think the sharing of ideas is how we make progress.

Dr. PEPPER. In addition, we've had two regulatory summits over the last three years in which the FCC Commissioners invited the chairs of each of the state regulatory commissions for a two-day meeting in a retreat-type of an atmosphere, where people can actually share ideas away from specific litigation and specific proceedings and work through the kinds of questions that you have raised today.

Mr. VALENTINE. Are they well attended?

Dr. PEPPER. They're very well attended. Our first one had 42 states represented. I forget the exact number at the second, but it was very similar.

And there's a lot of interest not only from the communications committee members of NARUC, but also from the chairs of the commissions across the board, people like Dr. Salmon who have responsibilities for not just telecommunications, but for water, gas, electricity, and so on. And I think that this is a very useful ap-

proach because it's less formal than some of the other types of meetings we have, but what we find is that there's a lot of common interest, and a lot of common knowledge, and that we learn a lot from one another. And I think that this is something that we're going to want to be pursuing.

I also want to thank you very much for the opportunity. I look forward to working with the subcommittee in the future.

Mr. VALENTINE. Well, we thank you both. When you have those seminars in the future, think of Pinehurst. There are a lot of golf balls and a lot of ants.

[Laughter.]

Thank you all very much.

Dr. SALMON. Thank you.

Dr. PEPPER. Thank you.

Mr. VALENTINE. And our next panel consists of Dr. Vinton G. Cerf, vice president, Corporation for National Research Initiatives at Reston, Virginia; Dr. Richard R. Green, president and chief executive officer, Cable Television Laboratories of Boulder, Colorado; and Dr. Brian Kushner, vice president, corporate development, Microelectronics and Computer Technology Corporation of Austin, Texas; and Mr. E. R. Kerkeslager, vice president, technology and infrastructure, AT&T, Basking Ridge, New Jersey, on behalf of the Computer Systems Policy Project.

Welcome, gentlemen. As I stated to the other panel, if you could summarize, we would appreciate it.

Dr. Cerf?

STATEMENT OF VINTON G. CERF, VICE PRESIDENT, CORPORATION FOR NATIONAL RESEARCH INITIATIVES, RESTON VIRGINIA; ACCOMPANIED BY RICHARD R. GREEN, PRESIDENT AND CEO, CABLE TELEVISION LABORATORIES, BOULDER, COLORADO; BRIAN KUSHNER, VICE PRESIDENT, CORPORATE DEVELOPMENT, MICROELECTRONICS AND COMPUTER TECHNOLOGY CORPORATION, AUSTIN, TEXAS; AND E. R. KERKESLAGER, VICE PRESIDENT, TECHNOLOGY AND INFRASTRUCTURE, AT&T, BASKING RIDGE, NEW JERSEY, REPRESENTING THE COMPUTER SYSTEMS POLICY PROJECT

Mr. CERF. Thank you very much, Mr. Chairman. I certainly appreciate this opportunity to testify before you and your distinguished colleagues on this committee.

I'm vice president of the Corporation for National Research Initiatives, which is a not-for-profit research organization founded in Reston, Virginia about seven years ago. Its focus of attention has always been information infrastructure, even when that subject was not so commonly used not only here on the Hill, but elsewhere. The phrase is now, I think, widely used and not necessarily well understood.

I also have the honor of serving as president of the Internet Society, which is drawn--whose members are drawn—from the millions of people who use the Internet system today. These people are variously users of the system; they are providers of the service; they are researchers and implementers of the technology. And they all share a common interest, which is to spread the existence, use,

penetration, and effectiveness and application of Internet-type systems wherever possible.

I think that if one is looking for an example of information infrastructure, you can come very close to it by looking at what happens in the Internet environment. Just to give you some "gee whiz" numbers, the system consists of more than 10,000 networks that are connected together. There are 1.7 million computers in the network all over the world. We don't know how many people use the system. There isn't any well-defined census, but we certainly believe there are at least 5 million people who are using the system. Moreover, it's connected to most of the electronic mail facilities around the world, and that increases the total number of participants to somewhere in the 10 to 20 million range.

I feel a little funny not being able to give you precise numbers about the scale of the system, but the fact of the matter is that it's not run by any central facility, certainly not by the Internet Society, although I get telephone calls from time to time from people who think we're responsible for running it, and that means I get either brick bats or bouquets. The fact is that it is an enormous collaboration among universities, government service providers, for-profit and not-for-profit organizations, campuses, businesses, all of whom have linked their systems together into this common infrastructure.

I think it's very important for this committee to understand that the origins of the technology came from United States Government initiative. Dr. Pepper mentioned that the ARPANET was the progenitor of the Internet system. And, indeed, it was the first public demonstration of the utility of packet switching at the time it was applied in defense applications for command and control. But it quickly became clear that the system was usable for many other things, particularly for the management of widely-spread research programs that were distributed all over the world. One has tremendous time zone problems in trying to get people to work together, and deferred communication through the electronic mail system on the ARPANET was a great boon to those of us who were trying to make those systems function.

In the subsequent years, since 1970, other government agencies have become very active in the development of the Internet technology: the National Science Foundation with its NSFNet; the Department of Energy with the Energy Sciences Network; NASA with its NASA Science Internet; Health and Human Services, particularly in the National Library of Medicine, whose Director you'll hear from later on this week; the Federal Networking Council, which is made up of many other agencies, in addition to the ones I've just mentioned. All are very active in promoting the use of and the further development and evolution of this technology.

I would like to caution the subcommittee, however, that there is a great deal more to infrastructure than networks, and the road analogy is tremendously beguiling. You can think of roads as being the networks, and the desktops are the sedans driving on the highways, and the laptops—and I've brought mine with me here—are the sports cars, and the supercomputers are the Formula One racing engines, and maybe the gigantic data storage systems are the 18-wheeler trucks that are going down the highway.

But this is a flawed analogy, and the reason I think it's important for you to take this in mind is that the model of the physical highway system is such that you have the superhighways, the interstates and the like; then you have major thoroughfares. You're not supposed to go as fast on them as you do on a superhighway. And then there are city streets and there's alleys and there's driveways.

And, typically, your behavior is different depending on which part of the transportation system you're on. But in a computer networking environment, it's actually okay to back out of your driveway at 900 miles an hour. Some people need to do that.

And the analogy is not very good when you think about typical road systems and you fail to take into account that computer communications—

Mr. VALENTINE. Let me ask you right there—

Mr. CERF. Yes, sir?

Mr. VALENTINE. —if we have to be concerned about these double trailers?

[Laughter.]

Mr. CERF. You certainly don't want the pedestrians in the information infrastructure to be run over by the double trucks; that's certainly true.

On the other hand, in this case the big, gigantic, supercomputer systems, and the ones that carry and store and respond to huge amounts of data are actually like the truckers, a friendly community there to help, there to deliver information when you need it.

So I want to emphasize that the information infrastructure is more than the network, albeit very dependent on a widely-spread, ubiquitous network. It's software; it's standards; and it's services that make up the information infrastructure. It's the software on the computers; it's the protocol standards that enable the exchange of information. It's not enough to deliver a bag of bits to a computer and expect it to do something with them. You have to have some agreement about what the form and structure and content and significance is of that bag of bits that shows up. That's what the protocols are all about.

And, on top of that, you need communication and information services embedded in this infrastructure that will support things like billing and accounting and advertising and order entry: electronic commerce. Literally, interoperability among all these computer components is everything. That is the infrastructure. It is the ability to exchange information between the computers that make up the system that creates an infrastructure upon which one can build an economic engine.

And I think if you listen in the background, as I'm sure you have, the sounds of roaring are an economic engine revving up for the 21st century. In fact, I think if one wants to try to push other analogies along, if the ARPANET was the Kitty Hawk of packet networking, then the Internet must be the Spirit of St. Louis, because it has reached out around the world, but it's only the Spirit of St. Louis. That was a single-engine plane, and I would report to the committee that research that's going on, sponsored by DARPA—I'm sorry, it's ARPA now—and the National Science Foundation, together with a great deal of contribution from indus-

try in high-speed networking, is aiming us in the direction of the jet travel of the future.

Some people think of the Internet and computer networking in general as kind of a frontier, a sort of 21st century frontier, and I've been living, along with many, many other people, in that frontier for the last 20 years. It's very interesting to consider what frontiers mean because, if you think about the software, which is essential to creating this information infrastructure, it creates an ever-changing, endlessly expanding frontier. You can do anything your creative imagination can dream of, if you can just get the software written. It's a small matter of programming.

The fact is that information and computer software are an infinitely renewable resource, and so the economic engine that can come from this kind of infrastructure is a magnitude beyond our ability to completely comprehend. We simply cannot imagine yet how much there is that's possible.

So now let me try to respond to the question of: what can the government do? And in order to answer that question, I sent an electronic mail message out to the people on the Internet, and I said, I'm coming here at the invitation of the subcommittee, and I want to know what you think I should say. I got back thousands of messages in my electronic mail system within days, and I managed to plow through most of them.

The point I want to make is that the comments came not just from the United States, but participants in the Internet from all over the world, from New Zealand, from France, from Germany, even from Somalia. One of the military responded in Mogadishu with some suggestions, like leaving as much of the telecom equipment there as possible if the country needs it.

Here are some things that the government can do: it can facilitate competitive network and information service provision. It can set up frameworks in which companies can compete. You heard that earlier in testimony. I think this is very important. The facilitation must involve helping the various competitors achieve commonality in terms of their technical interfaces, and that leads to another thing the government can do and has been doing: facilitate, support, and participate in voluntary technical standards development. And the government does that. It has supported the Internet technology development. It continues to do so, and I believe that has been a major investment.

Another thing that the government can do is sponsor public domain software development. Let me try to say more clearly what I mean. In the growth of the Internet, one of the major factors has been the availability of software, developed, for example, on university campuses, made freely available to anyone who wants to use it, to turn laboratory software into products and services. The federal government sponsors the research work that takes place in the universities. The university students get their degrees, and then of course they go to work in industry, and industry has taken much of that software and turned it into, at great investment, very powerful products and services that are now sold all over the world.

I think another major issue that the subcommittee should take into account in creating this information infrastructure is to examine, re-examine our export control limitations on cryptography, spe-

cifically the data encryption standard and public key crypto systems. The reason I bring this up—and we have no time to really explain all the details, but we need those technologies uniformly everywhere in order to deal with intellectual property management problems, copyright protection, authenticity of transactions, dealing with electronic data interchange. We must have that kind of ability, technical ability, to assure that the traffic maintains its integrity, has not been falsified by the originator, and so on. For contractual electronic commerce, things like the data encryption standard, and public key crypto systems, are essential technologies, and at the moment we don't allow them to be widely exported. There are great limitations on this, and it interferes in many instances with our companies' abilities in the U.S. to compete with others.

Another thing that the government can do is to subsidize library and educational uses of computer and communication networks. These are sectors of the community that benefit everyone. And in a sense, by such subsidies, we'll make steps toward minimizing the gaps between information-rich and information-poor. And if we are to achieve an information infrastructure for the country, we must assure that such gaps are erased.

Finally, I invite the subcommittee to become a part of the existing information infrastructure of Internet, and learn what it's like to live in the 21st century. You'll be welcome there. Don't forget to bring your computers.

Thank you very much.

[The prepared statement of Dr. Cerf follows:]

Written Testimony of

Dr. Vinton G. Cerf
Vice President
Corporation for National Research Initiatives

and

President
Internet Society

US House of Representatives

Committee on Science, Space and Technology

Subcommittee on Technology, Environment and Aviation

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Corporation for National Research Initiatives
1895 Preston White Drive, Suite 100
Reston, VA 22091
+1 703-620-8990
+1 703-620-0913

National Information Infrastructure

INTRODUCTION

Mr. Chairman, distinguished members of the subcommittee and guests, my name is Vinton G. Cerf and I am Vice President of the non-profit Corporation for National Research Initiatives (CNRI). I also have the honor to serve as President of the Internet Society (ISOC), which is a professional society of individuals who are users, developers or operators of the Internet. My remarks today are personal in nature, but they are colored by my past and present professional experiences which form the backdrop against which my opinions and observations have evolved.

I worked on the ARPANET project while a graduate student at UCLA in the early 1970s, helping to develop the protocols used to support communication between the computers ("hosts") on the network. The highly successful ARPANET experience with packet switching technology led to additional satellite, mobile radio and local area packet networks, developed under Advanced Research Projects Agency (ARPA) sponsorship and, in the case of Ethernet, at the Palo Alto Research Center of the Xerox Corporation. Dr. Robert Kahn, now the president of CNRI, initiated an ARPA internetting research program to explore techniques to connect different packet networks in such a way that the host computers did not have to know anything about the intermediate networks linking them together. Dr. Kahn and I developed the idea of gateways and wrote the first specification for the basic TCP/IP protocols now used in the Internet.

The idea behind Internet was the seamless linking of many different kinds of packet switched networks. I came to ARPA in 1976 to manage the Internetting research program and by the time I left ARPA in 1982, the TCP/IP protocols were widely used and the Department of Defense had declared them standards for military use. The Internet has blossomed in the subsequent 10 years, particularly after the National Science Foundation (NSF) introduced the NSFNet as part of the Internet in the mid-1980s. In 1982, there were about 100

computers on the ARPANET and a few score others were part of the NSF-sponsored CSNET which also used the Telenet public data network. In 1993 there are over 1.5 million of them. The system links over 10,000 networks in roughly 50 countries. Although it is not known for certain how many users there are, we believe there are well over 5 million. The system is tied into most public and many private electronic messaging services and this expands the population able to exchange email to some 15 million. They include business people, academics, government workers, scientists, engineers, librarians, schoolteachers, astronomers, oceanographers, biologists, historians, reporters, attorneys, homemakers, and secondary school students .

The system is doubling annually in users, networks, hosts and traffic. In some parts of the Internet, such as the NSFNet backbone, traffic growth rates as high as 15% per month have been measured. Internet is growing faster than any other telecommunications systems ever built, including the telephone network. Today, over half of the networks registered are associated with business users. Of course, these rates of growth cannot continue indefinitely, but there is reason to expect that the user population will exceed 100M by 1998.

Perhaps even more important, this federal investment in research has created new industries revolving at first around the hardware and software of Internet technology, and more recently, around network and information services supported by the Internet. The new businesses (such as Sun Microsystems, 3COM and Cisco Systems) have highly positive international trade balances and phenomenal growth, commensurate with the rapid growth of the Internet itself. The growth rate is extremely strong in Europe, South America and the Pacific Rim creating major export markets for the US firms offering Internet products and services.

In 1975, operational management of the ARPANET was transferred to the Defense Communication Agency (now the Defense Information Systems Agency - DISA). In the mid-80s, the National Science Foundation (NSF), the Department of Energy (DOE), and the National Aeronautics and Space Administration (NASA) joined in supporting the evolution of the Internet and developing and applying its technologies. In

addition to developing their own networks (that became integral components of the Internet), these agencies participated in the development and standardization of the Internet protocols (TCP/IP Protocol Suite) and provided support to the secretariats of the Internet Architecture Board (IAB) and Internet Engineering and Research Task Forces (IETF and IRTF). This included support for the Internet Assigned Number Authority (IANA), document editor ("RFC Editor"), and Network Information Centers which provide information and assistance to users and deal with Internet network address assignments. ARPA, NSF, DISA, DOE and NASA now make up part of the Federal Networking Council which continues to oversee the development of networks used in government-sponsored research and education.

Formed at the beginning of 1992, the non-profit, professional membership Internet Society provides an institutional framework for carrying out a variety of activities intended to foster the continued growth, evolution and application of the Internet. Included in this undertaking is the responsibility for the technical standards used in the Internet. Along with members of the Federal Networking Council, the Internet Society supports the IETF Secretariat. It sponsors conferences and workshops on the Internet and its technology, is establishing liaison relationships with the International Telecommunication Union (ITU) and Organization for International Standardization (ISO), works with various United Nations agencies (e.g. UN Development Program) to encourage the acquisition and use of Internet facilities in technologically-emerging countries, and participates in efforts to extend Internet services from university and research library communities to secondary school systems.

The Internet Society does <u>not</u> operate any of the thousands of networks that make up the Internet, but it assists service providers by providing information to prospective users and involves product developers and researchers in the evolution of Internet technical standards. Corporate and individual, professional support for this organization is widespread and international in scope.

High Performance Computing and Communication

The High Performance Computing Act was signed into law late in 1991. The original impetus for this legislation came from then-Senator and now-Vice President Gore whose vision of "information superhighways" limned the potential of a computing and communications infrastructure which would permeate and stimulate the government, business and private sectors of the US economy. The promise of a vast new economic engine equal to or larger than the engine sparked by the National Highway Act of 1956 was a powerful incentive for this bill and lies at the heart of the motivation for creating a new National Information Infrastructure.

One of the key elements of the HPC initiative is its National Research and Education Network (NREN) program. Designed to extend the performance envelope of networking into billion bit per second ("gigabit") territory and to extend the scope of access to a larger segment of the research and education communities, the effort spawned a major research program on gigabit networking. ARPA and NSF jointly funded an effort, organized by the Corporation for National Research Initiatives, to establish multiple gigabit testbeds across the United States. The program is highly leveraged, involving major contributions from the computing and communications industries as well as several of the national laboratories and major research universities .

An important focus of the gigabit testbed program is to discover by experimentation which technologies and applications are likely to form the core of the high performance communication systems of the future. The deep involvement of industry is intended, in part, to assure that the results take into account the plans and capabilities of the private sector. Such partnerships among government, industry and academic institutions form a bedrock upon which new national infrastructure can be founded.

The vision of the NREN component of the HPC effort begins with the existing US component of the global Internet. Under the NREN program, key parts of the US Internet have been extended to operate at 45 million bits per second (in particular the NSFNet) and procurement of higher speed services by DOE

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and NASA is in progress. The gigabit testbed program is enabling the early availability of very high speed network technology and the results of the program will help to determine the architecture and technology of even higher capacity services. The NSFNet initiative, which began in 1986, has also led to the creation of dozens of new Internet service providers, including a number of for-profit networks offering unrestricted Internet service to all who desire it.

Another fundamental motivation for the high performance networking component of HPC is the intense investment by the principal interexchange and local exchange telecommunications carriers in the US in the use of optical fiber in their networks. Capable of supporting operation in the billions of bits per second, the optical networks form the strands from which a national gigabit fabric can be woven. Investments by local exchange carriers and cable companies to increase the capacity of the lines reaching business and residential customers make it possible to envision a time when very high capacity services can be supported on an end-to-end basis.

The far-sighted vision of the HPC effort, together with the explosive growth of the Internet and basic communications facilities resulting from private sector initiatives, have set the stage for a dramatic new step in the evolution and convergence of computing and communication: the creation of a National Information Infrastructure.

INFRASTRUCTURE

Information Infrastructure is the "common ground" on which computer-based products and services depend to achieve commonality and interoperability. Included in infrastructure are technical standards and the organizations and procedures through which they are developed; communication services and the physical, human and organizational resources needed to deploy, maintain and operate them; legal and regulatory frameworks which encourage cooperative development of precompetitive technology, foster the protection of computer-accessible intellectual property, the protection of privacy, and support the conduct of electronic commerce; widely available computer software for many hardware and operating system platforms establishing ubiquitous and interoperable comput-

ing environments in which applications can be embedded. Infrastructure supplies the raw material out of which limitless applications may be constructed.

Some of the characteristics which mark elements of infrastructure include: ubiquity, expandable capacity, simplicity of use, applicability to many uses and broad affordability. A functioning information infrastructure will lower technical and economic barriers to the introduction of computer-based products and services. It will simplify the discovery and ordering of products and services as well as billing for their use or acquisition. It will also facilitate the day-to-day operation of businesses, government, education, health care and all the myriad activities that rely increasingly on the use of computer and communication technology to accomplish their objectives.

Infrastructure has an enabling character. The highway system enabled the suburban housing boom and convenient, door to door delivery of goods. Of course, it also stimulated the automobile industry and travel. The power generation and distribution system enabled the facile application of fractional horsepower motors and a vast array of other electrical appliances wherever they were needed.

Infrastructure development is almost always preceded by critical inventions which motivate the need for the infrastructure. The light bulb preceded and motivated the need for power generation and distribution. The invention of the internal combustion engine and its application in automobiles motivated the need for better roads, service stations, gasoline refining and distribution. Once the roads were in place, their ubiquity and easy accessibility stimulated the production of a vast array of different vehicles, all designed to conform to certain common constraints (size, height, weight) so as to be usable on most of the roads in the system.

The computer is the automobile of the information infrastructure. Laptops are the sports cars; desktops are the sedans; supercomputers are the formula 1 racing engines; and gigantic mainframe data storagesystems are the 18 wheelers. The local access networks form the neighborhood streets; high capacity computer networks are the superhighways; and circuit, cell and packet switching systems form the complex interchanges.

Just as vehicles on the road can be filled with an endless variety of people and products performing a multitude of services, software applications fill the empty computing vessels to create the new products and services of the information infrastructure. Communication protocols and standards form the rules of the road. When traffic jams and accidents occur, we call on emergency services to assist. The same may prove true for the information infrastructure when viruses infect the system or other software and/or hardware failures occur; we will need comparable emergency assistance to restore critical services and functions.

The Electronic Frontier Foundation speaks of computers and computer networking as a "frontier in cyberspace." This is an interesting and apt analogy, given the relative immaturity of both technologies. Despite the apparent sophistication of today's computers, networks and software, their application has barely scratched the surface of the latent possibilities. The notion of frontier raises images of boundaries and limits. But cyberspace is a virtual place. It is created out of software, making cyberspace an endlessly expandable environment.

Information is, itself, an infinitely renewable resource to be harvested, shaped, applied and recycled. The products and services which can be built atop the computer and communication infrastructure simply have no logical limits. It is this ceaselessly changing, growing, transmuting information resource which will fuel the economic engine of the information infrastructure.

INFORMATION INFRASTRUCTURE FORMATION

The technical challenges to be overcome in creating a national information infrastructure may only be overshadowed by some of the legal and policy problems. Taking the easier ones, first, it should be apparent that standards for the exchange of a variety of types of information (data) are essential. The value of infrastructure is that providers of two services which must interwork do not have to make bilateral agreements with every partner if appropriate technical standards are developed which enable such interworking. In the case of program (software) interworking, common representations of shared information

must be agreed upon so that software developers can be reasonably assured that, if they follow the protocols, their application programs will interwork with each other.

A variety of high and low-level standards are needed for representation of digital documents; information retrieval queries and responses;remote program interactions; financial or other commercial transactions; privacy, integrity and authenticity preservation; and a plethora of application-specific standards for information interchange. These representations need to include the capability for a wide range of media, including sound and pictures. There are a number of representations available for encoding these various media, but there is not yet widespread agreement on a common set. Consequently, we are still some distance away from a workable information infrastructure.

The applications that can be supported on a suitable information infrastructure are limited only by imagination and creativity. Examples include health care support (e.g., patient information, prescription databases, digitized X-Rays and MRI scans), remote consultation); education (classrooms without walls, using the information infrastructure to receive instruction, explore digital libraries and work with distant partners), manufacturing, provision of government information, and support for electronic commerce (e.g., order entry, electronic or physical delivery of products, electronic payments, product specifications).

An important element of Internet growth is the typical pricing strategy of service providers: flat rates based on the bandwidth of the lines used to access the Internet. Unlike some commercial email and other public data network service providers, Internet service providers have not charged by the "packet." Many believe that this policy has had a major, positive effect on the growth of the network because users had little uncertainty with respect to annual costs for use of the system.

ANECDOTES FROM THE 21ST CENTURY

Those of us who have lived with the Internet since its inception have been living in what will be common in the next century.

In preparation for this testimony, I sent a brief message out on the Internet to hundreds of thousands of people who make daily use of the network. I asked them to offer their thoughts on points they considered important to make. Within hours, I had thousands of responses, not just from domestic sources but from all over the world. Without the infrastructure of the Internet, such a question would not have been worth asking since the answers would have taken far too long to receive, and I could not have applied available computer cycles to sort and sift the resulting responses. My correspondents were almost uniformly enthusiastic about the prospects for national and global information infrastructure. The following were some of the points they made:

- The Internet Society newsletter is created by correspondents all over the globe who email their stories to the editors in Los Angeles, California and Reston, Virginia. The whole process takes places over a few days, with all the editing taking place on-line. Each issue is available on-line within minutes of completion through a variety of information services on the Internet.

- A professor at the University of Southern Louisiana offered to teach a class on Internet use through email on the Internet. 15,000 people applied to take the class! This is "distance-learning" with clout!!

- A blind student of Shakespeare asked on the net, "where can I get on-line copies of the plays, it's the only convenient way for me to read them." He uses a text-to-speech and text-to-Braille device. He got back many pointers to on-line archives around the world.

- When President Clinton and Vice President Gore were visiting Silicon Graphics in California's Silicon Valley, the audio and video of the speeches were packetized and "multicast" on the Internet to hundreds of participating sites. This is an example of the nascent potential in combining all forms of communication in computer-mediated form.

- Internet Talk Radio recently made the front page of the New York Times - it is another example of the convergence of digital computer communications and mass media.

- When I needed information about the Spratley Islands, I just turned to the CIA World Fact Book made available on the Internet by the University of Minnesota.

- A technical problem arose with an application running on an Apple Macintosh. The user sent an email message to several distribution lists and news groups and got back helpful responses, some in minutes, from France, Germany, Italy, Australia, India, Singapore, Canada, England, Norway, United States, Finland, ... well, you get the idea. Cyberspace has common interest groups that transcend national boundaries.

- The city of Wellington, New Zealand, has a computer on the Internet. It has placed there a wide range of information of interest to potential visitors and tourists, local residents, and Internet explorers. There is strong historical evidence that the rich personal interactions that take place on the Internet contribute to a marked increase in face-to-face meetings requiring travel, so the local government is to be commended for its foresight.

IMPORTANT THINGS THE US GOVERNMENT CAN DO

Offered below is a representative set of comments and suggestions received over the course of a few days from the Internet community. Because of its source, it has an obvious Internet bias to it, but despite that, I think these ideas are worthy of serious consideration.

1. Invest in the development of pre-competitive software and technology which is made available to industry for competitive productizing. Historically, universities have developed sample implementations of new Internet software which is then used as the basis for product and service development in industry. Occasionally, industry will sponsor development of freely available software which can be readily distributed throughout the network, creating a kind of mini-infrastructure on which

more elaborate, for-profit products and services may be based. In both cases, new businesses are often created to service the market created.

2. Foster and facilitate the development of technical information standards through cooperative efforts among industry, academia and government. The procedures of the Internet Engineering Task Force are a model for expeditious and effective development because the standards must be implemented by multiple parties and shown to interoperate before they are eligible for standardization.

3. Revisit COCOM and US-specific policy on the application, use, and export of the RSA and DES cryptographic technology. Present policies inhibit the creation of particular aspects of global information infrastructure and, in some cases, US companies are placed at a severe disadvantage relative to competitors. These technologies are key elements [no pun intended] in solving problems of intellectual property protection and management and electronic commerce in an on-line environment.

4. Adopt the TCP/IP protocols as coequal with the OSI protocols in the US GOSIP specifications (which describe the profile of protocols that are recommended for use in Government procurements). The TCP/IP protocols are already in wide-spread use within the government, so this change would merely acknowledge reality.

5. Move aggressively to support library access to Internet services, with particular attention to rural community access.

6. Institute training programs to educate the nation's secondary school teachers and support staff on the use of computer and communication technology in the classroom. Subsidize access where this is necessary. Involve state educational infrastructure in this effort. Review highly successful state-level programs as input to national policy development.

7. Stimulate the development of quality software for use in curricula at all levels. Consider programs to develop pre-production software and make it available at no charge, leveraging

the creativity of national laboratories, universities and individuals.

8. Mandate public, on-line availability of government-produced or sponsored information and allow the private sector to add value and resell it. For example, the White House is providing on-line access to unclassified executive orders and text of speeches by senior administration officials within hours (and sometimes minutes) of their release.

9. Foster programs to explore and experiment with the use of information infrastructure to support telecommuting. Not only as an energy-saving, pollution-reducing step, but a major tool for implementing the Americans with Disabilities Act provisions. It was noted that home-employment and suburban satellite offices illustrate that electronic communication infrastructure is approaching the importance of the more concrete (pun intended) traffic highways.

10. Make use of the Internet to harvest information from its tens of thousands of public databases as an adjunct to intelligence gathering and analysis by various agencies of the federal government. Make available government unclassified information and analysis via the Internet as a contribution to the community (e.g. CIA World Fact Book).

11. Get all branches of the government on electronic mail and support the ability to exchange email with the public.

12. Encourage the deployment of ISDN services.

13 Foster the development of shared scientific databases and collaboration tools which can be used to enhance the utility of research results and provide access to raw as well as analyzed data to support corroborating research.

14. Make use of the Internet to build bridges among the scientific, research, academic and educational communities.

15. Link the museums of the world on the Internet.

16. Avoid the unintentional creation of a gap between information rich and poor. The concern here is that private

sector entrepreneurship may conflict with freedom of access to public information. Note that the potential gap problem applies equally as well to individuals and to large and small corporations!

17. Position national policy so that the government need not subsidize network service providers. Rather, subsidize users, where this is appropriate. By this means, remove most of the Appropriate Use Policy dilemmas from consideration at the network level. It is not technically possible today, using existing capabilities, to distinguish different classes of traffic at the network level. [There were a few people who thought the government should build the National Information Infrastructure but the vast majority who commented on this preferred private sector service provision, albeit under government policies which assure ubiquity of service, full interconnection of all service providers and reasonable costs].

18. Find a way to make advertising permissible and useful in the National Information Infrastructure.

Mr. VALENTINE. Thank you, Dr. Cerf.

Before we move on to the next witness, Dr. Green, let me ask a question, and I want you to think about it some as you give the rest of your testimony. Is there potential in what we attempt to do here for an electronic search warrant? The reverse—we have been talking about getting stuff into homes. Is there a potential also for getting stuff out? What I mean is all kinds of private and confidential stuff.

Dr. Green?

Dr. GREEN. Thank you, Mr. Chairman and subcommittee. My name is Richard Green, and I am president of Cable Television Laboratories. I want to thank you for this opportunity to discuss how cable technology is contributing to the development of a modern telecommunications infrastructure in the United States.

My message is two-point and straightforward: first, the U.S. cable industry has in place today a communications network that can deliver dozens of channels of television, and a complete array of multimedia services to most American homes. Indeed, cable companies have built the only broadband electronic pipeline into the American home.

The network is currently available to 97 percent of U.S. television households, and serves about 62 percent of them. Cable is positioned to provide the all-important connection necessary to bring an information superhighway into homes and schools.

Secondly, the cable industry is making substantial new investments and will over the next few years dramatically expand its capabilities. With the use of fiber optics, digital technology, new system architectures, and improved consumer electronics, cable companies are creating an even more advanced network. This network will be able to deliver such productivity-enhancing services as high-speed file sharing between computers, telecommuting, video on demand, and two-way video conferencing.

The entire national cable infrastructure can be upgraded to provide two-way interactive multimedia services for a fraction of the estimated $400 billion required for telephone companies to comparably rebuild their local networks. The cable industry is making this investment now, and is providing an array of new high-tech jobs which are essential to economic growth in communities across the land. Moreover, the cable industry's investments are privately financed, are very cost-effective, and have no public funding.

Many of the improvements that cable companies are making today to provide better television service are exactly the same steps required to transfer cable systems from television-only carriers to high-capacity, high-speed digital networks. The essential element of cable's success, however, has been its deployment of coaxial cable to the home. Co-ax is a flexible, insulated wire which comes in several sizes, including the finger-size drop cables which are used to wire individual homes. The importance of this drop wire is both its ubiquity and its capacity.

When cable companies began offering only a few channels of television 30 years ago, they provided each of their customers with a coaxial pipeline that is capable of carrying 150 channels of television. The coaxial cable which is used in every American cable

home can carry at least 900 times the information that can be carried on the twisted pair copper wires.

Using digital compression technology, the drop cable's current capacity of 150 channels of television can be increased to 600 to 800 channels. Cable companies have thus invested, from day one, in a pipeline to the home that can carry every proposed information age service.

By subsequently grafting fiber onto the existing feeder cables that run through the neighborhood, cable companies have developed the full potential of their broadband plants at minimal cost. This so-called fiber-coax hybrid network has enormous capacity and can be installed very cost-effectively. Fiber trunk lines enable cable operators to activate upstream, digital communication paths from home to the headend. By making cable systems two-way and digitally-capable, a whole variety of information age services are now available, such as personal communication services and computer applications, including multimedia and distance learning.

Now here are a few examples of the technical advancements now being introduced in communities across the country. These projects are outlined in detail on page 14 of the written testimony, but I will just give you a very brief description.

Fiber and two-way transmission: Time-Warner's newly constructed cable system in Queens, New York utilizes extensive deployment of fiber optics and other state- of-the-art capabilities. The system provides one gigahertz of capacity into 3,000 homes, carries 150 channels, and offers an extensive video-on-demand capability. Viacom is upgrading its Castro Valley, California system to fiber and two-way capability.

Time-Warner and Viacom are two of the 26 cable companies which have been granted an experimental PCS license. These licensees are actively installing facilities to carry two- way signals necessary to test that service.

Digital deployment: TCI has also announced the introduction of digital compressed video service to homes beginning the first quarter of 1994. This service will provide the first high-data-rate digital service to the home. It will carry 20 megabits per each current TV channel. Several other leading cable companies, including Comcast, Newhouse, and Cable Vision Systems, have announced similar plans.

Electronic superhighway: Time-Warner has announced plans to serve suburban Orlando, Florida using the world's first full-service network inaugurating the electronic superhighway into the home. This system will feature full two-way video transmission and digital switching which will allow interaction between subscribers.

Cable Vision Systems has completed the first phase in an electronic superhighway to homes, businesses, and institutions in the New York City metropolitan area. The system will immediately offer point-to-point digital services, distance learning, and alternate access services under agreements with MCI and AT&T. One immediate application is the establishment of a high-speed fiber optic link to transmit X-Rays along medical research and teaching centers in Long Island.

And, in conclusion, with systems such as these, the cable industry is delivering the information age to Americans today. It has

been said that the future information superhighway will be like America's system of intercoastal waterways. Rather than a single river, it will be a network of many interconnecting tributaries. What I have said today is that cable is not a single river, but is the vital tributary—is a vital tributary and is set to contribute mightily to the emergence of the national information network.

Thank you, Mr. Chairman. I'll be glad to answer questions.

[The prepared statement of Dr. Green follows:]

Testimony of

Dr. Richard R. Green
President and CEO
Cable Television Laboratories, Inc.

before the

Subcommittee on Technology, Environment, and Aviation
Committee on Science, Space, and Technology
United States House of Representatives
Washington D.C.

March 23, 1993

I. INTRODUCTION

Mr. Chairman, Members of the Subcommittee, my name is Dr. Richard R. Green. I am President of Cable Television Laboratories, Inc. and want to thank you for providing me with the opportunity to discuss how cable technology is contributing to the development of a modern telecommunications infrastructure in the United States.

Cable Television Laboratories, or CableLabs, is the research and development consortium of the cable television industry. Based in Boulder, Colorado, CableLabs is a joint venture of various cable companies which represent 85 percent of U.S. cable subscribers, as well as Canadian companies which serve the majority of cable subscribers in Canada. This consortium exists because of the leadership that Congress demonstrated in 1984 when it passed the Cooperative Research Act, which allows industries to establish joint research and demonstration efforts. The consortium approach has greatly facilitated the transfer and application of telecommunications technologies to cable television networks.

I have a very simple message for the Subcommittee today:

First: The U.S. cable industry has in place today a communications network that can deliver dozens of channels of television and an array of multimedia services to most American homes. Indeed, cable companies have built the only broadband electronic pipeline into the average home. This network is currently available to 97 percent of U.S. television households and serves more than 61 percent of them.

Second: The cable industry is making substantial new investments that will dramatically expand its capabilities over the next few years. With the use of fiber optics, compression technologies, new system architecture, and improved consumer electronics, cable companies are creating a network that will be able to deliver such productivity-enhancing services as high-speed file sharing between computers, telecommuting, video-on-demand, and two-way videoconferencing.

Mr. Chairman, the cable industry is making investments in these new technologies and services today — they are not merely pipedreams on someone's drawing board. Moreover, the cable industry's investments are privately financed, with no public funding; they are relatively inexpensive and very cost-efficient. Most important, the entire cable infrastructure can be upgraded to provide two-way interactive, multimedia services for about $20 billion — which is just a fraction of the $400 billion required for the telephone companies to comparably rebuild their local networks.

Many of the upgrades which cable companies are making today to provide better television service are exactly the same steps required to transform cable systems from television-only carriers to high-capacity, high-speed digital networks. By using fiber and going digital, the cable television industry is building major information highways that are more affordable and closer at hand than many now appreciate. In the pages that follow, I wish to highlight cable's progress in upgrading its network -- in particular, its

deployment of fiber optic trunk lines. I also want to describe the "next-generation upgrades" now being designed and implemented, such as the extension of fiber optics to individual neighborhoods, digital compression, and the addition of data-communications capabilities.

But before I get too far ahead of myself, let me briefly review the history of the cable industry and how how it has reached its current position.

II. CABLE'S PROGRESS TO DATE

Cable television is the nation's major video service provider, with more than 61 percent of all U.S. TV households now subscribing to our service. Moreover, nearly all American households can be served by cable. Of our country's 93 million television households, 91 million (97 percent) have access to a coaxial cable that runs along or near ("passes") their property line. Of those who subscribe to cable, almost 95 percent receive more than 30 channels while 35 percent receive 54 channels or more.

During the past decade, cable's growth as a telecommunications medium has exploded. The number of homes able to be served by cable grew from 35 million in 1980 to 91 million in 1992, while the number of households subscribing to cable leapt from 18 million to 57 million, as the following table demonstrates:

TABLE I

Cable's Growth, 1975-1992

	1975	1980	1985	1990	1992
TV households (millions)	70	78	86	93	93
Homes passed (millions)	23	35	65	86	91
Homes passed as percent of TV households	33	45	76	92	97
Cable subscribers (basic, in millions)	9	18	40	55	57
Basic cable as percent of TV households	13	23	46	59	61
Average system channel capacity	12 *	20 *	24	35	39

Sources: TV households, cable subscribers: A. C. Nielsen Co.
Homes passed, channel capacity: Paul Kagan Assoc., Inc.
* NCTA estimate

As cable companies have wired the nation, the cable industry has been a technological innovator. Research sponsored by ATC, the predecessor of Time Warner Cable, in the mid-1980s led to major breakthroughs in optoelectronics — the transmission of signals through fiber-optic strands. In addition to their own private company labs and R&D programs, the cable industry spends $12 million annually to fund CableLabs. While the amount in dollars of cable's R&D efforts is small compared to Sematech or Bell Labs, the entrepreneurial, budget-conscious approach of the cable industry has consistently produced big payoffs.

Coaxial Cable

Wiring America for cable has been the largest private construction program since World War II. Cable systems were originally built in rural America to provide homes with broadcast signals that did not reach them over the air. As cable systems grew, they developed a "cascade" architecture whereby television signals were sent from the cable "headend," or collection point, down trunk lines to feeder cables and eventually to drop cables. This network of coaxial cable — heavy gauge at the headend, lighter gauge at the home — was punctuated by amplifiers necessary to deliver the signals to the furthest homes in the system.

The secret to cable's success has been its deployment of coaxial cable to the home. "Coax" is a flexible, insulated copper or aluminum wire which comes in several sizes, from 3/4 inch trunk lines to 1/4 inch "drop" cables (which are used to wire individual homes). The importance of this "drop" wire is both its ubiquity and its capacity: even when cable companies only offered 6-10 channels of television 30 years ago, they wired each of their customers with a coaxial pipeline that is capable of carrying 150 channels of television. Indeed, the coaxial cable which is used in every American home can carry at least 900 times the information that can be carried on the telephone companies' "twisted pair" copper wires.

With digital compression, the drop cable's current capacity of 150 channels of television can be increased to 600-800 channels. Cable companies have thus invested from day one in a pipeline to the home that can carry every conceivable information age service -- without having to be replaced or upgraded. Moreover, the finger-sized drop cables constitute 50 percent of the wiring in a cable system and represent the bulk of a cable company's investment in plant.

By grafting fiber onto the existing feeder wires and trunk cables that run through neighborhoods, cable companies can easily tap the full potential of their broadband plant at minimal cost. This so-called "fiber-coax" hybrid network has enormous capacity and can be installed very cost-effectively. The same is not true for the telephone companies, which must rip out and replace every wire into every home in order to upgrade their plant from narrowband to broadband capacity.

Upgrading With Fiber Optic Trunk Lines

Since 1984, when Congress passed the Cable Communications Policy Act, the cable industry has spent $17.14 billion on construction, $6.5 billion of which went to rebuilding and upgrading existing facilities. A key element of these upgrades has been the introduction of fiber optics into cable systems. Installation of fiber optic trunk lines — which clean up signals, increase reliability, and cut operating costs — is accelerating rapidly, with fiber plant (FSA — Fiber-to-the-Service-Area) growing from 13,000 miles in 1991 to 23,000 at the end of 1992 (see pp. 6-8 and Figure 1).

Recently, TCI and Time Warner made major announcements about increasing the amount of money they will spend on improving their network infrastructure through the broad use of fiber optics. TCI said it would increase capital spending to $750 million this year, compared with $450 million in 1992. TCI has also announced that its investment in fiber will enable it to go fully digital within five years.

As noted, these fiber optic upgrades are being achieved at remarkably low overall costs. This is because a cable system's trunk lines account for only 15 percent of total plant investment. (As I have discussed, 50 percent of that investment is in coaxial drop lines to the home, which will remain in place.) Cable companies are rapidly installing fiber optic trunk lines to neighborhood nodes of about 1,500 to 2,000 homes, at a cost of about $50 per subscriber.

Cable is carrying out this ambitious fiber trunking program with no public funding, federal or otherwise. In fact, cable pays substantial amounts to local governments in the form of franchise fees, which totalled $917 million in 1992.

The Benefits of Hybrid Fiber Optic/Coaxial Cable Networks

The current switch-over to fiber optic trunk lines by cable companies is highly cost-effective because it permits the removal of amplifiers, which previously had to be located at quarter-mile intervals along all-coaxial systems. These amplifiers decrease the number of channels that can be carried by coaxial cable and are a source of possible breakdowns and high maintenance costs. Moreover, in boosting signal strength, they also decrease signal quality, thus creating potential problems for customers at the edges of large cable systems. Finally, amplifiers are vulnerable to power outages which lead customers to complain to their cable company — not the local utility — when service is disrupted.

Another advantage of fiber is that it facilitates return signals from the home, thus making cable's entire fiber/coaxial plant interactive. Amplifiers tend to be one-way devices, communicating signals from the headend to the consumer but interfering with return communications. By removing amplifiers, you not only remove their signal distortions but also the limitations which they impose on two-way interactive services. Fiber trunk lines are helping cable operators to activate an upstream, digital communication path from the home back to the headend.

For now, this upstream data path is used largely for ordering pay-per-view movies and events. But its potential applications are much greater. For example, in late February 1993, Adelphia Communications announced a plan to rebuild the cable system in Syracuse, New York, which serves more than 38,000 customers. Adelphia will use an architecture that provides 120 television channels, eliminates coaxial amplifiers, and extends fiber deep into the cable network, close to the home.

III. FUTURE CABLE SYSTEM UPGRADES

Even as the cable industry upgrades its facilities with fiber-optic trunks and feeder lines, several companies are now beginning to place large purchase orders for two other equally powerful enhancements to their systems:

* Digital Compression — using part of a cable system's capacity to transmit video that has been digitized and then "compressed" — a much more efficient use of the pipeline; and

* Fiber to Neighborhoods — extending the fiber beyond the main trunk lines and out into neighborhood "nodes" of 200 to 500 homes.

As cable companies carry out these two parallel processes over the next few years, they will, in effect, be transforming cable systems into high-speed digital transmission networks. Like fiber trunk lines, these upgrades make business sense in their own right, helping cable companies provide more TV channels and clearer, more reliable video signals. But once a cable network "goes digital," a whole variety of "Information Age" services will become possible, as the following discussion illustrates.

Digital Compression

Digital television abandons the traditional method of broadcasting — analog waves (which are continuous variations in current, akin to a dimmer switch on a dining room light) — in favor of digital transmission (a system in which a computer takes frequent numeric samples of analog waves, e.g., the chandelier's brightness, and transmits the results as a string of ones and zeroes). To transmit the massive information content of a TV picture, these digits are compressed, meaning that much of the redundant or unnecessary information is harmlessly discarded by mathematical processes to save space on the pipeline.

Cable engineers have devised a scheme for superimposing compressed, digitized channels onto the same fiber optic wire or coaxial cable that is also carrying conventional "analog" TV signals. Space savings in the pipeline can be dramatic: anywhere from 4 to 16 compressed video channels can go into space that carried just one analog channel, depending on the subject matter and the required picture quality. As a result, cable companies can use digital compression to double or quadruple their channel capacity in a very short period of time.

To date, U.S. cable companies such as Tele-Communications, Inc. (TCI), Viacom International, Inc., NewChannels (a division of Newhouse Broadcasting), and Comcast Corporation, as well as Canada's Rogers Cablesystems, have announced agreements to buy digital compression equipment — as has the Public Broadcasting Service (PBS) for the "education satellite" it plans to activate next year. TCI said that it alone would spend $200 million on compression upgrades. The reports are that Comcast has ordered 150,000 digital converter boxes and NewChannels, 250,000 boxes. The cable industry hopes to recover this investment in new channel capacity with revenues from two sources:

* Pay-per-view programs, with the most in-demand movies beginning perhaps every 15 minutes — in competition with video cassette rental stores. Broadcasting with many convenient starting times has been called "near video on demand", a system in which subscribers select the desired starting time of the program.

* Niche-audience channels or a-la-carte services providing special programming to narrowly targeted audiences. One plan is for an "Aviation Channel" targeting 2.5 million real and would-be private pilots. The expectation is that these channels will be offered at low, a-la-carte prices (generally $1-$4 a month).

Subscribers may purchase these pay-per-view programs or a-la-carte channels either by sending orders upstream (on 2-way systems) or by calling a phone number to activate a signal that is sent down to their cable converters' unique digital "address" to decode the requested programming. These compression upgrades are very cost-effective because the special converters required to decompress the digital signals need only be provided to subscribers who wish to buy the new services.

Digitally compressed formats will also be used to transmit programming from its point of origin to cable system headends via satellite and long-distance fiber-optic lines. In fact, compression of the "long-haul" portion of the delivery system is already underway, with programmers like Home Box Office currently offering compressed digital programming which combines four programs on one satellite transponder. The four million owners of "backyard dishes" in the United States will have access to decompression equipment so that they can view the new digital satellite signals and enjoy the same programming seen by cable subscribers.

Extending Fiber Optics to Neighborhoods

The extension of fiber optic lines to neighborhood "nodes" of 200-500 homes will spread widely in the coming years. Because it permits reduction of active electronic devices like amplifiers, the use of fiber in trunk and feeder lines greatly increases the capacity of the final coaxial cable drop to the home (see Figure 1).

Not too long ago it would have been impossible for me to make such a statement. But the cable television industry has conducted a successful search for optics technology that could accomplish the job. It is technically and economically desirable for fiber to transmit the standard AM analog signal used by existing television receivers. When we first looked for this technology, we found that available lasers were not sufficiently linear to propagate AM signals — the second and third order distortions built up over a short distance and severely degraded the primary signal.

Laser manufacturers said that we were dreaming — that there was little hope for developing lasers that could pump out 50 or more channels in AM and send them the 10 to 20 miles required to make effective use of fiber. But a few cable companies saw it differently. The results today tell one of the remarkable technology stories of the 20th Century. Cable operators are now installing fiber links carrying up to 80 channels from a single laser to neighborhood pockets as small as 500 households — and they are doing it for about the same cost as traditional coaxial technology.

We call this design "star/bus topology" or "FSA" for fiber-to-the-service-area (see Figure 2). There are several variations: the service area may have as few as 500 households or it may have as many as 2,500. With a new rebuild, the cost/benefit analysis usually dictates deeper penetration of fiber into the neighborhood than with an upgrade of an older system. Either way, the judgment throughout the industry is that breaking up the system into pockets served by fiber trunk is the best way to accomplish the typical goals of any cable construction project.

The net result of cable using fiber is better signal quality, fewer service outages, and more channels for our subscribers. Notice that I did not include two-way communications or on-demand programming for our customers in the list of immediate benefits. Indeed, we do not have to factor the revenues from such new capabilities into the cost-justification equation for fiber — they are an automatic outgrowth of using fiber.

FSA systems are being deployed across the country. Systems are under construction in Spokane, Washington; Troy, New York; Norfolk, Virginia; Rochester, New York; Castro Valley, California; Waterbury, Connecticut; St. Petersburg, Florida; Exeter, New Hampshire; Columbia, South Carolina, and many, many other locales. In fact, virtually anywhere there is a fair-sized construction project underway, cable operators are turning to FSA as the design of choice.

I have talked about how new cable networks will enable our companies to target services and interactive communications, and I will have more to say about this later. But, first, let me stress another major aspect of FSA's evolution. I mentioned that fiber is facilitating the expansion of usable bandwidth. In fact, the prevailing bandwidth target of 550 MHz, or about 77 analog television channels, is made easier by using fiber. But as you know, the ultimate bandwidth potential of fiber is far greater, extending into the multi-teraHertz range. Although it is not yet economical or practical to use this full bandwidth, it would be helpful to at least double the bandwidth of existing cable systems. (Current capacity is limited by the amplifiers remaining on the coax link between the fiber node and the customer.)

As you may be aware, fiber is being used to extend the bandwidth of cable plant to 1 GHz. This has been done in the Time Warner system in Queens, New York, where subscribers have access to 150 AM video channels, including more than 50 channels of pay-per-view programming. This bandwidth is obtained by reducing the number of amplifiers between the fiber node and each household to no more than two. The upgrade is accomplished with current, off-the-shelf electronics and without any major disruptions of existing facilities. Time Warner's calculations show that it obtained the extra 30 channels (in addition to the existing 70) for merely $50 per subscriber. Clearly the cable industry is able to enjoy major cost savings in the evolution of its networks -- especially when compared to those who suggest building broadband networks from scratch. The cable industry is so confident that 1 GHz+ bandwidths are achievable at low cost that in most FSA designs, all the passive components, as well as the placement of active components, are geared to rapid expansion beyond 550 MHz. In other words, when these FSA-based systems need to grow to 1 GHz or more, they will be able to do so quickly and cheaply.

The Marriage of Fiber and Digital Compression

Cable companies are moving quickly to take advantage of the benefits derived from combining fiber to the neighborhood with digital compression. For example, Time Warner's Orlando network will use a hybrid fiber/coax plant to bring together digital compression, high-speed packet switches, and video servers. This network will be capable of providing virtually any telecommunications service when linked to a "smart" consumer converter box.

As a result of these new technologies, which it helped develop, the cable industry could rebuild all of the existing cable plant in the United States (currently passing 97 percent of TV households) for somewhere around $20 billion -- far less than the $400 billion it would cost for a comparable rebuild of the existing telephone infrastructure.

Members of this Subcommittee may have seen an article recently in The New York Times which quoted figures from Columbia University on the relative costs of upgrading cable and telephone networks.[1] While the data leave some questions open, and I quibble with some of the guesstimates, they are useful for illustrative purposes. For example, the data indicate that to deliver "next generation" services — primarily voice and video -- it would cost the cable industry from $50 to $300 per subscriber (for a total of $5 billion to $30 billion), versus $1,500 per subscriber for a telephone company ($75 billion to $150 billion).

1. "A Baby Bell Primed for the Big Fight," New York Times, February 21, 1993: Section 3, page 1.

These two technological developments -- digital compression and the extension of fiber to neighborhoods -- will create a growing abundance of video channel capacity and a rapid decline in the cost of delivery per channel. This trend has implications for those providing programming of an educational or cultural nature. For instance, the entire content of PBS' planned 40-channel "education satellite" could be made available at low cost not only to schools and libraries (which will receive the service on their own satellite dishes) but over cable as well.

IV. LONGER TERM IMPLICATIONS OF CABLE'S NEW INFRASTRUCTURE

The capacity expansions described so far (fiber optic upgrades and digital compression) have served only to enlarge the cable pipeline so that more content can be sent to everyone in a "broadcast" or "point-to-multipoint" method of communication. But a longer-term benefit of the digitalization of program content will be the ability to route content from a sender to a single receiver (known in telecommunications as "point-to-point" communication).

Customized, Point-to-Point Communications

All digital bits are essentially alike — whether they carry a movie, an opera, an electronic newspaper, or a phone call. A video program, once digitized, looks like any other digital data stream. In computer networks, data move from one point to their intended destinations(s) because they are tagged on the front with a small bundle of identifying digits known as a "header." Video programming is no different. Like any other data (CD-quality music, videogames, or live videoconferences), digital videos pass through switches that route them to their intended destination(s) in one or more homes. Since the bundles of data are know as "packets" and the packets move through a network at very high speeds, this routing technique is known as "fast packet switching."

Just as PCs brought the computing power of large, distant mainframes to the desktop (distributed computing), the trend in telecommunications is toward decentralized switching capability that is closer and closer to the end user (distributed switching).

The cable industry is designing a network that borrows from the latest distributed fast packet switching techniques developed for high-speed data communications. Cable companies are currently evaluating and testing different switching techniques, including asynchronous transfer mode (ATM), a method which is fast gaining acceptance as a worldwide digital communication standard, and IBM's packetized automated router integrated service (PARIS) packet-switching technique.

It is not an exaggeration to say that digital compression and ATM for cable are here as practical options for the future. We still have to work through the issues involving operating protocols, and the cost of equipment has to be reduced to a level where cable operators view a shift to digitally compressed service (i.e., putting digital video decoders in the home) as a profitable move. However, the satellite headend decoder equipment is already at cost parity with standard channel reception receivers.

Clearly, there is no technical barrier to making digital compression a real part of our network operations. This means that the 550 MHz FSA networks we are installing today will soon be able to deliver an astonishing number of services. Let us assume that, for a while at least, we continue transmitting our standard offerings, the types of services that go out to everyone in broadcast mode, in standard AM format. For the typical cable system, this probably equals 40 channels of programming. That leaves about 40 channels for digital services.

I mentioned earlier that through compression, we will be able to squeeze up to ten NTSC channels on each six MHz of bandwidth. It turns out that movies can withstand especially large amounts of compression, such that it is possible to carry eight or more movies per 6 MHz channel, depending on which vendor you use (one company says it can do 13 movies per 6 MHz).

Let us say that we devote three quarters of our new digital spectrum to movies and that we choose conservative compression ratio options: we are then looking at about 300 on-demand, pay-per-view movie selections in this model. This leaves another 60 MHz for other digital services, such as sports channels, which would operate at a ratio of 3 or 4 per 6 MHz. Or maybe they could be education services, which would operate at the same or even higher compression ratios as movies (PBS has been experimenting with 20:1 compression ratios). Or maybe they could be the first HDTV offerings in the video marketplace, where each 6 MHz channel delivers a single HDTV channel. Or maybe they are multimedia services.

In rolling out fiber and digital compression, the cable industry has created a self-expanding, broadband network, designed from the start to accommodate new imaginative services at very low incremental costs. If 400 to 1,000 channels can be sent to a neighborhood of 300 homes, channel capacity becomes so great that individual channels can be sent to individual homes, or even individual viewers within that home — a true video-on-demand capability.

Regional Hub Fiber Optic Interconnects

To complement its emphasis on increased reliability within individual cable systems, the cable industry has also begun creating regional fiber optic networks in some major metropolitan areas. These "fail-safe" interconnections will enable an entire region's systems to share resources and services (such as video playback machines and advertising insertion equipment) by collocating them at a single facility called a regional hub (see Figure 3).

Regional hubs will have links to the outside world, pulling video, audio and "multimedia" content from shared satellite dishes or from long-distance fiber optic carriers. (In today's computer industry parlance, the term "multimedia" denotes a mixture of digital information including video, audio, text, graphics, and animation.) They will provide access points to local cable systems for other networks including national information/electronic hi- local exchange carriers, inter-exchange carriers, alternate access carriers, satellites, microwave, cellular and PCS providers, and off-the-air-broadcasters.

The interconnection of the regional hub to cable headends will likely be through a ring topology. The ring consists of broadband, "self-healing," dual-alternating, analog and/or digital fiber links. The ring is the topology of choice due to its favorable economics, high reliability, and ability to ensure diverse routing. The ring topology enables large and small cable operators to interconnect a wide variety of advanced applications over a broad area (e.g., an entire city, suburban, or county area). It also puts cable companies in a good position to transport both entertainment programming and interactive services.

The ring can provide coverage for wide geographic areas either independently or by coupling smaller rings off the primary loop. The ring can support a service area 200-miles wide; with coupled rings, coverage of a larger geographical area is possible. Many of the ring transport facilities already exist and can be leased through alternate access providers or metropolitan area network providers. Alternatively, they could be owned by a cable operator. The net result will be an evolutionary, cost-effective way for the cable industry to meet the needs of the future. Indeed, the regional hub concept will provide the cable industry with the ability to establish uniform service offerings for large and small operators alike. It will be especially important in allowing cable operators to share costs and provide better, cheaper, and more reliable service to their customers — especially in inner-city and rural areas.

From a technical standpoint, we believe that there is an evolutionary path which leads to an almost ideal entertainment delivery system and leaves open many options with regard to other information and communication services. The cable industry has charted a path which allows it to keep costs low while greatly expanding the convenience and variety of services that cable networks offer their customers. Beginning with the installed base of broadband coaxial cable in the local loop, and aided by technologies like fiber optics, microcomputers, compression, mass data storage, and digital switching, the cable industry has tools at its disposal to construct a system which delivers almost any imaginable entertainment, education, information or communication service.

The information provided over cable may originate from any source — including national repositories of video, audio and textual data, and ranging from Paramount Pictures to USA Today to the Smithsonian Institution. The content can either be sent in a broadcast mode, available to any subscriber, or it can be "switched" to a single business, home, or group of subscribers. It can travel at a time dictated by the sender (for example, an electronic newspaper sent every night) or when requested by the recipient (on-demand ordering of a little-known movie, a videoteleconference, or any other electronic product).

Digital Mass Storage

Steady advances in digital memory technology are making mass-storage devices -- the repositories for all digitized films, CDs, videogames, electronic shopping catalogues, and other content — increasingly affordable. For example, with the 256 megabyte memory chips now under development, an entire feature-length movie could be stored on four to ten memory chips, each smaller than a dime. Frequently requested information would be stored on such

chips, which are relatively expensive, while less-used material would be housed on less expensive media, such as optical disks and magnetic tape. Once content is digitized, the bulk and unreliability of videotapes are eliminated: moving a video or multimedia program from one site to another becomes almost as easy as copying a computer program from one drive to another on a personal computer.

Cable as a Data Communications Carrier

Both CableLabs and individual cable companies are expanding their collaboration with computer companies with the goal of transforming cable's networks into data communications pipelines. This emerging cable-computer industry collaboration is rapidly opening up the cable industry to many new innovative applications.

As part of its Ethernet on Cable project, Digital Equipment Corporation (DEC) needed only four days to turn a cable TV system in Hudson, Massachusetts, into a conduit for transmitting high-speed Ethernet data signals (including computer files and two-way voice communication) so that hundreds of its employees could work at home, or "telecommute." (Ethernet is a widely used format for exchanging data over local-area and wide-area computer networks.) Other implementations of high-speed, two-way data communications are running on cable systems in Cupertino, Castro Valley, and Milbrae, California, and in Portland, Oregon.

Similarly, TCI is involved in a Defense Advanced Research Projects Agency (DARPA) funded project with Hybrid Networks Inc. of Cupertino, California; their goal is to link San Francisco's regional cable interconnect into the Internet, a federally fostered computer network with more than 8 million users, by July 1993. This project could be the forerunner of a widespread interlinking of cable systems with the Internet and its planned successor, the National Research and Education Network (NREN) — with the latter designed to carry not only text and static graphics but also multimedia content.

As mentioned earlier, computer companies like Microsoft, Apple, and IBM are eager to use cable's broadband pipeline to reach customers. Cable industry leaders have told computer industry figures that cable would be willing to accelerate or alter its network development in response to the computer industry's multimedia agenda.

It was just about two years ago that Jim Albrycht introduced Digital Equipment Corporation's concept of ETV -- Ethernet via cable television -- which DEC has also dubbed Community Multimedia Networking. Basically, the concept is to extend the reach of the 10 mbit/second Ethernet protocol everywhere by tying in LANS and individual work stations to the cable network. The idea has gone from suggestion to implementation on an ever wider scale. For example, in Portland, Oregon, the ETV connection is being used to help manage a community sanitation system. In Milbrae, California, schools are applying ETV to data processing functions. In Dallas, Texas, and on the western slopes of Colorado, cable operators and DEC are well along in discussions about how best to use the technology for a variety of purposes, including education, medical image transmission, and work-at-home. And in Hudson, Massachusetts, where Jim Albrycht first worked with Cablevision

Systems to test the ETV concept, the experiment is about to expand into an ongoing work-at-home application for some of DEC's design engineers. This will afford them the opportunity to work long hours without spending all of their time at the office.

TCI, the largest cable company, has expanded its ties with DEC. Their agreement provides for joint development of applications, such as video conferencing, telecommuting, medical imaging, high-speed data and specialized services for health care and education. Similarly, Cablevision Systems has been looking at technical options, including wireless, to accelerate the availability of ETV or other LAN-type service extensions.

CableLabs is currently defining two sets of protocols for data communications over cable. The first is for relatively slow-speed, one-way communication, and will be put into use early in 1993 by providers of electronic program guides and other services. The second is a high-speed, two-way protocol capable of transmitting many types of multimedia content.

Much has been said about the hardware interface, ranging from the chipsets for digital compression to the routers that will switch cable services, to the boxes that will bring computing power to every household. People especially love to speculate about how the PC will converge with the television set and how that one-machine-does-all capability will revolutionize the consumer marketplace. For what it is worth, my own feeling is that once signals are delivered digitally to the home, we will see a whole range of different types of equipment entering the marketplace, from monitors attached to multiport, intelligent servers to highly integrated processor/playback machines.

Electronic Publishing

Through the use of regional fiber optic networks described above, the cost of starting digital services such as program guides and interactive distance learning programs can be shared by several cable systems. Then, as the services becomes more popular, their information content will be moved to computers and mass-storage devices closer and closer to the subscriber.

The electronic publishing field is due for an explosion. For example, Apple and CNN have jointly developed a prototype of an "electronic magazine" with video-on-demand news segments. Knight-Ridder, Inc., has a prototype electronic newspaper. Both prototypes feature a versatile user interface that permits searching and cross-referencing that are impossible with their print counterparts. Cable companies want to be the carrier of choice for these and other services.

The cable industry's program guides will be an early multimedia initiative with simple video on demand. Creating such a system is thought to be a good investment because sales of movies and other programming will presumably be greatly enhanced when viewers can call up full-motion video previews of the programs.

At the far reaches of cable's digital transformation, cable networks are potentially usable for voice phone and videophone service. While technical and regulatory hurdles remain, cable companies could make their networks available to other companies, such as cellular-phone operators.

One type of phone service that cable companies are testing is the experimental wireless telephone system called Personal Communications Services (PCS). Another promising option for wired systems is being developed independently by First Pacific Networks, AT&T, and other companies. These ventures support both high-speed data communication over coaxial cable and phone service (including videoteleconferencing).

V. CABLE SYSTEMS OF THE FUTURE

Several leading cable television companies currently are rebuilding existing systems into state-of-the-art networks which demonstrate the many potential services that can be delivered by cable television. These projects are not just on the drawing boards -- two went into operation in 1992; the other three are under construction.

Time Warner - Queens, New York

Time Warner's newly constructed cable system in Queens, New York is utilizing extensive deployment of fiber optics and other state-of-the-art capabilities. The system, which currently serves over 3,000 homes, carries 150 channels (compared to the industry average of 40), and offers an extensive video-on-demand capability called Quantum. This programming service gives customers the ability to choose from a wide variety of movies and events at any time of the day on 55 different channels. Five recent box office hits are available on multiple channels to allow for each title to start every half hour with occasional titles starting every 15 minutes. The technology design and use of fiber also allows for testing of innovative telecommunications services such as Personal Communications Services (PCS).

Time Warner plans to expand the Queens system to eventually serve 10,000 homes. The company is assessing consumer reaction to its service to determine when and how to introduce similar technology in its other service areas.

Tele-Communications Inc. - Denver, Colorado

In a pioneering, cooperative effort with AT&T and US West, TCI is conducting an extensive test of a video-on-demand service called Viewer Controlled Cable Television (VCTV) in a suburb of Denver, Colorado. The test is comparing viewer preferences for two types of expanded video service. Consumers in 150 homes have a selection of movies on 24 channels, with hit movies carried on multiple channels so that they will be available every half hour. Another 150 homes have a choice of over 1,000 movies and other programs to view at any time; they also have the ability to pause a movie in the middle of viewing. The Discovery Channel will be providing several documentaries to be part of the 1,000 title video library.

This test is also innovative in combining the talents of several companies. AT&T will design the VCTV "Control Center," including hardware and software. US West will provide a fiber optic link from the VCTV Control Center to the TCI headend to allow integration of the new services with TCI's conventional cable system offerings. Equipment testing began in April 1992, and the experiment is expected to run 18 months.

In addition, TCI has announced the introduction of digital compressed video service on its systems beginning in the first quarter of 1994. This service will provide the first high data rate digital service to the home. It will carry 20 megabits on each TV channel and can provide up to 500 channels of digitally compressed television on any cable system. The company is placing orders for one million digital set-top converters and has begun construction of a $20 million digital video processing and uplink center in the Denver suburbs. Several other leading cable companies including Comcast, Newhouse, and Cablevision Systems have announced similar plans.

Viacom - Castro Valley, California

Viacom is upgrading its Castro Valley system to "full impulse, two-way active" capabilities. This will allow Viacom to offer a variety of video-on-demand and interactive programming services. The system will utilize fiber-to-the-feeder technology and will allow for the testing of experimental telecommunications services such as Personal Communications Services (PCS).

Time Warner - Orlando, Florida

Timer Warner Inc. announced on January 27, 1993, that it is planning to build "the world's first full service network inaugurating the electronic superhighway into the home" in suburban Orlando, Florida. The network will be providing service to 4,000 residential customers by early 1994. The services that will be offered include full video-on-demand, interactive full-motion video educational services in conjunction with local schools and universities, and interactive video games, which customers will be able to play with other subscribers on the network. The system will feature full two-way video transmission, and digital switching which will allow interaction between subscribers.

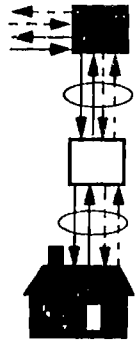
Cablevision Systems - New York Metropolitan Area

Cablevision Systems recently announced the completion of the first phase of an "electronic superhighway" to homes, businesses, and institutions in the New York City metropolitan area. The system includes a fiber backbone, and will immediately begin offering additional video channels, impulse pay-per-view, point-to-point digital services, distance learning, and alternate access services under service agreements the company has signed with MCI and AT&T.

One immediate application has been the establishment of a high speed fiber optic link among medical, research, and teaching centers on Long Island. For example, researchers will be able to transmit x-rays from the State University's cancer therapy facility at Brookhaven National Laboratory to physicians at the university's hospital.

With systems such as these, the cable industry is delivering the Information Age to Americans today. A cornerstone of our nation's hybrid communications infrastructure, cable is the only industry that can deliver broadband services — at low cost and no expense to the taxpayer. It has been said that the future information superhighways will be like America's system of intercoastal waterways. Rather than being a single river, it will be a network of many interconnecting tributaries. What I have said today is that cable is not a single river: it is a vital tributary which is set to contribute greatly to the emergence of a seamless national information network.

Network Architecture
Network Migration



Headend

Fiber

Fiber Node

Coaxial Cable

Subscriber

——— Analog
- - - - - - Digital

Fig. 1

CableLabs

Network Architecture

Network Migration - Existing

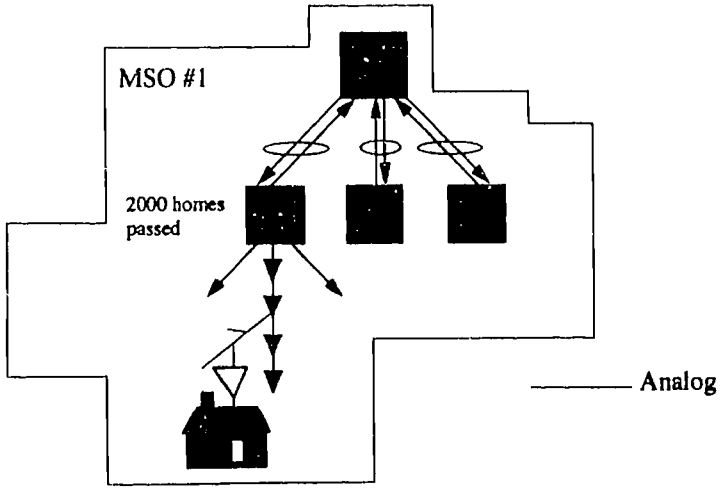


Fig. 2

CableLabs

69-545 0 - 93 - 4

Network Architecture

Regional Hub Concept

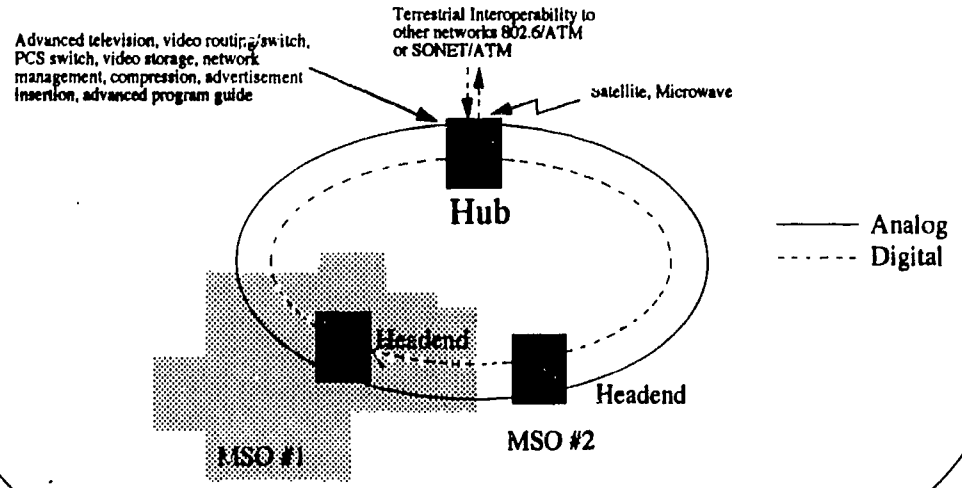


Fig. 3

CableLabs

CableLabs
Cable Television Laboratories, Inc.

Dr. Richard R. Green
President and Chief Executive Officer

Richard R. Green is President and CEO of Cable TV Laboratories, Inc. (CableLabs). In this position he heads the organization responsible for charting the cable television industry's course in technology.

Prior to CableLabs, Green was senior vice president of broadcast operations and engineering at the Public Broadcasting Service from 1984 where his contributions included construction of a national network origination and transmission facilities. For the 1-1/2 years before that, he helped organize and establish the Advanced Television Systems Committee, a multi-industry-supported organization founded to develop voluntary national standards for advanced television.

From 1980 to 1983, Green was director of the CBS Advanced Television Technology Laboratory in Stamford, Conn. In addition to his work at CBS in digital television and high definition TV, Green participated in the international standardization efforts that date from the late 1970's and chaired the committee that eventually developed CCIR Recommendation 601, a worldwide television standard for digital signals. He is currently chairman of TG11/1, a CCIR committee charged with the responsibility of recommending a worldwide HDTV studio standard.

While at CBS, Green helped to produce the first series of experimental programs mastered in HDTV in the United States. The CBS/NHK/Sony efforts yielded the first football game (Rams vs. Redskins, 1981), the Rose Bowl Parade, an episode of the Fall Guy television adventure program, and a series of cinema segments all photographed in HDTV. Green also assisted in the production of a series of HDTV programs in 1982 in cooperation with European broadcasters including SFP France, BBC, Swiss Television and Soviet Radio & Television.

From 1977 to 1980, Dr. Green managed ABC's Video Tape Post Production Department in Hollywood and from 1972 to 1977 did basic research in laser technology for the Hughes Aircraft Co. in Los Angeles. Green served as a senior staff scientist for Boeing Scientific Research Laboratories (1964-1972), and an assistant professor at the University of Washington (1968-1972).

Green is a member of Phi Beta Kappa, the American Association for the Advancement of Science, and the Society of Motion Picture and TV Engineers. He is the author of more than 55 technical papers on topics ranging from TV production to electro-optical and laser research. He is presently chairman of Task Group 11/1 of CCIR, a group considering international production standards and other interface issues relating to HDTV, and is chairman of a Working Party of the FCC Advisory Committee on HDTV. Most recently Green was voted *CED*'s Man of the Year, and selected by *Electronic Media* as one of 12 people in the U.S. media to watch in 1993.

A native of Colorado Springs, Green holds a B.S. degree from Colorado College (1959), an M.S. in physics from the State University of New York in Albany (1964), and a Ph.D from the University of Washington (1968).

1050 Walnut Street, Suite 500 • Boulder, Colorado 80302 • Telephone: 303/939-8500 • Fax: 303/939-9189

Mr. VALENTINE. Thank you.

Dr. Kushner?

Dr. KUSHNER. Good morning, Mr. Chairman and members of the subcommittee. I appreciate the opportunity to testify today on the development of an information infrastructure, an abstract and analogy-laden concept, and on the efforts that we at MCC are currently undertaking to the vision that I think is uniformly shared among all the members of this panel, and the members of the previous panel, of an information superhighway a reality.

Just to put it in context, I and my staff are the double trailer users of the Internet and we are the 900-mile-per-hour drivers on it. Many of my staff are also—have been teachers on some of the television, cable television industry's programs, such as Mind Extension University and others that have facilitated distance learning.

I just wanted to say a word or two about MCC to put my following remarks in context. MCC is one of the country's leading electronics, computer, and information systems consortia. We have over 70 companies, such as HP, Motorola, Digital Equipment, IBM, AT&T, NCR, Hughes, Bellcore, Regional Bell Operating Companies, Apple, Microsoft, The Limited, and American Express, to name but a few as our members. We also have many small businesses, and we have just recently inaugurated a small business partnership program. We believe that small businesses, in fact, are the engine of economic growth, and will also provide many of the jobs that may emerge out of this industry in the future.

To put things in context, MCC's members' annual revenues total about $500 billion, roughly 10 percent of U.S. Gross Domestic Product, or roughly equivalent to the economy of Canada. Through cooperation and collaboration, competing companies reduce technical and market risks, leverage their investment in pre-competitive technologies and services, and bring valuable products to market.

MCC presently has two major initiatives in information infrastructure underway. First Cities, our program to develop interactive multimedia services to the home and our Enterprise Integration Network, to provide many of those same capabilities, though by different application services for business-to-business communication. This involves many of the same items that were identified previously: protocol and software standards, services, and applications.

First Cities is, despite a common vision, an initiative to be developed that reduces market risk preventing the growth of interactive multimedia networks for the home. Many of the elements of the common vision, such as having movies on demand, interactive games, personalized news services, financial services, teleconferencing, have been stated and very clearly elucidated by previous testimony before this subcommittee.

Our First Cities is a collaborative effort to overcome many of these market risks, figuring out exactly what consumers will buy and what they will pay, what the affordability is, what the operations and costs are, what the regulatory issues are, and to do that through market trials. Initially, wiring up distributed groups of 5 to 10 thousand homes, later expanding into the hundreds of thousands of homes, and to explore various delivery mechanisms.

There's fiber; there's cable; there's twisted pair; there's wireless. There are issues associated with architectures, providing security. The comment that you made earlier about electronic search warrants; being able to provide some level of security to those systems, we view as very important.

These trials will test the currently unknown consumer demand, test the technology and the interoperability of these delivery systems, and overcome the standards risk, and focus on synchronized deployment of hardware and software to overcome the asynchronous deployment risk. We also view this as an opportunity for small business with applications software, such as those that have been developed by a few of the small businesses in the Philadelphia area and in the San Francisco area, to help people in distance learning, education, environment, things of that nature.

Our technology study that kicked this First Cities program off, involved over a dozen companies, such as Apple; Bellcore; COMSAT; Corning; Hughes; Kaleida Labs, the joint venture between IBM and Apple; Southwestern Bell; Tandem Computers, and others. We are currently involved in just kicking off our phase two of our program on March 1st, which is the implementation of the laboratory integration testing, interoperability, and site selection. Site selection will be completed in 1993 for trial sites. Our first site will be operational in 1994.

The second technology program I'd like to mention to you is our Enterprise Integration Network, which was the result of 18 months and greater than 100 companies working to define a sophisticated electronic business network. We call it the industrially-hardened Internet. The vision is that thousands of companies producing, buying, and selling information goods and services all need to be connected by some type of highway and interaction. We believe that competitiveness demands on being able to provide these facilities and services and capabilities, to increase agility, decrease time to market of goods and services, and reduce costs.

To give you an example, the Gardner Group, a market research firm, has recently identified that 30 percent of America's largest companies currently outsource greater than 50 percent of their goods and services to subcontractors and other vendors. It is expected that, in the next three to five years, over 60 percent will outsource more than 50 percent of their goods and services.

Many of these firms, that are very large, are already creating their own networks. Two of our members, Boeing and The Limited, already have their own proprietary networks. Boeing, for example, spends nearly $400 million to be able to operate and maintain their network, to be able to reach their vendors and suppliers electronically.

Many of these networks that are taking shape, and already in existence, are closed and proprietary. We've seen that issue before. It also creates very prohibitive costs for small business entry. In the case of the Boeing network, that is in excess of $100,000 to be able to just gain entry onto the network.

We've also found that many of these networks can't communicate. Imagine what would happen if the phone system were not universal, if you had a different keypad, or televisions all worked differently as you traveled from city to city. It's a very challenging

problem; and we need to be able to facilitate the interoperability, and the connectivity to be able to make these networks play together.

Enterprise Integration Net will allow more universal open communication, without specialized equipment and software. Make me a small technical indulgence. What will be created, specifically, is a uniform interface layer to isolate network protocols, the physical layers, and the applications from each other. The analogy is much like the applications programming interface found currently in an Apple Macintosh that Dr. Cerf picked up or Microsoft Windows, or MOTIF and UNIX systems.

It will provide the services needed to really do business electronically: directory services, security services for electronic information and data, and user authentication, multimedia mail and more intelligent E-MAIL. I, as a user, receive a minimum of about 50 E-MAILs, electronic mail, messages a day, in some cases more than 100, and I would love to have some mechanism to be able to more intelligently sort them out.

Financial transaction services, design information being shared back and forth, computer-aided design, computer-aided manufacturing, and manufacturing software—all being communicated over the Enterprise Integration Network. We believe this network eliminates barriers to most efficient production and distribution of goods.

Our approach to implementation has been to involve consortia, such as the Electric Power Research Institute and the National Center for Manufacturing Sciences, and to work through those entities, in addition to our own members, to reach their members and involve them in being part of the electronic future.

What is the role of government that we see? Both at present, EINet and First Cities are industry-led and industry-funded. We believe that government can make early short-term stimulative investments leading to a faster deployment of a better infrastructure. The current efforts that are underway do deserve support. The HPCCI, High Performance Computing and Communication Initiative, the NREN, agile manufacturing and manufacturing technology programs in the Department of Defense, the manufacturing network initiatives within the Department of Commerce, and proposals to encourage the development of education, health care, environment, and retraining applications that may exist over these networks, all of which serve public sector purposes, I believe would be very beneficial and should be supported.

There are a few points I'd like to call to your attention. Too little attention is currently being paid to extending the information infrastructure to homes and small businesses, particularly providing interoperability, so that consumers can mix and match. No agency has clear responsibility and mandate to be able to support either the market trials, or the testing and the interoperability, of these systems.

Whomever you and others decide has the charge to do that should have the power to do three things. One, support industry efforts to develop technical standards to ensure the interoperability. Very often, today's standards become tomorrow's limitations. How many of you bought eight-track tapes, or how many of you remem-

ber early versions of the MS DOS Operating System and are still living within the 640 K barrier?

The second item I would like to recommend is development of public sector applications, such as the ones I just mentioned previously: health care, environment, distance learning, retraining applications, all of which will be beneficial.

The third is to extend the reach of network-based services to the households and small businesses that would not otherwise receive them. Very often, that's based on affordability, and the small businesses pay, and the homes pay. In many cases we don't even know what we should be charging.

There's a final point I'd like to bring to your attention. The government and information infrastructure programs need to be agile, flexible, and rapid in order to keep pace with the train that industry is moving along. Key developments are taking place today. The efficiency of public-private partnerships will depend upon the ability of committees such as yourselves and the administration, to act quickly. The current nine-to-12-month lag to obligate funds, even after they've been appropriated, will be disastrous in information infrastructure, particularly for small businesses that are commercializing specific elements of the technology, and counting on those funds and other small business innovative research grants to be able to keep themselves afloat.

Some progress is being made in the right direction by groups such as DARPA, with their other transactions authority, and the National Technical Information Service, with their joint venture authority. These are to be applauded and hopefully expanded.

More is really needed. I urge the committee to support and encourage progress in this area, and to take this issue into account as it proceeds.

Thank you very much for the opportunity to testify before the subcommittee this morning, and I'd be happy to answer any questions that you may have.

[The prepared statement of Dr. Kushner follows:]

Testimony of
DR. BRIAN KUSHNER
Vice President, Corporate Development
MICROELECTRONICS AND COMPUTER TECHNOLOGY CORPORATION

Subcommittee on Technology, Environment and Aviation
Committee on Science, Space, and Technology
March 23, 1993

Good morning, Mr. Chairman and Members of the Subcommittee. I appreciate the opportunity to testify today on the development of an information infrastructure and on the efforts we at MCC are currently undertaking to make the vision of an information superhighway a reality.

WHAT IS MCC?

As many of you know, MCC is the nation's leading research and development consortium for the electronics and computer industries. MCC's mission is to enhance the competitiveness of our member companies through cooperation and collaboration. Our members are a diverse group of over 70 outstanding electronics, computer, telecommunications, aerospace, manufacturing, and information technology companies. They include Hewlett-Packard, AT&T, Motorola, Apple, Microsoft, Eastman Kodak, and many other well-known companies. MCC also has membership categories for small businesses and universities, so that they, too, can contribute to and benefit from collaborations with other MCC participants. The combined revenues of our member companies in 1991 was just under $500 billion, a little under 10% of the U.S. Gross Domestic Product, or roughly equivalent to the GDP of Canada.

Companies benefit from their participation in MCC in several ways. By participating in MCC's cooperative research projects, member companies leverage their research dollars; minimize the risk of engaging in high risk, longer term, potentially high-impact technology development; and they reduce duplication of R&D efforts. Beginning is 1990, our member companies expanded MCC's traditional mission to include reducing market as well as technological risk. These activities include applications development, small business commercialization, and market trials. To implement these, MCC also works with member companies to accelerate the implementation of standards and define open architectures and protocols to minimize market risk , increase agility, and maximize inter-operability and market potential.

MCC EFFORTS IN INFORMATION INFRASTRUCTURE

A little over a year ago, MCC's board approved a new technical vision to guide MCC in its second decade of research. That vision is based on the consensus of our participants about the most significant trend in information systems over the next several years and into the 21st century.

That trend is the emergence of a global information infrastructure, connecting us whether through fixed and portable devices to a wide range of products, services, and capabilities that change the way we work, play, and inform ourselves.

MCC has two activities underway in the area of information infrastructure that are of particular interest to the committee this morning. The first is First Cities, our project to bring the information infrastructure and interactive multimedia to the home. The second is Enterprise Integration Network, or EINet, our effort to create an information infrastructure among businesses.

In both of these activities, MCC is coordinating the efforts of several companies to minimize the risk and maximize the benefit of private investment in the information infrastructure. Cooperation among competitors from diverse industries can reduce the risks for all participants; the result can be faster deployment of a better information infrastructure, financed largely by the private sector.

These MCC activities are industry led; currently all or most of the operating budgets are supplied by MCC and its member companies. It is our view that the government need not make enormous investments to bring the information infrastructure to fruition. Instead, the government can and should make early, but crucial stimulative investments in partnership with industry, and in so doing produce enormous benefits for American consumers, American business, and the government itself.

FIRST CITIES: INFORMATION INFRASTRUCTURE TO THE HOME

Over the next decade, the emergence of digital multimedia information networking will have an enormous impact on virtually every individual, and every public and private institution. Consumers will have convenient access to a wide variety of high quality, reasonably priced goods and services which will simplify their lives and expand their capabilities. They will call upon unprecedented levels of information, communication and entertainment, available on a highly personal basis, to educate their children, to increase access to health care, to assist them in working more effectively, to enhance leisure time, and to improve the quality of life.

This is a commonly shared vision, and there are relatively few technological impediments to achieving it. Yet multiple efforts to bring interactive multimedia networks to a significant number of American homes have not succeeded. Why? Because there still exists a vicious cycle of risk and inaction.

There has been no way to date to truly test consumer preferences for broadband, interactive, network services -- to offer them goods and services and see how much if anything they are willing to pay for them -- because the necessary networks have not been widely available. But there is no financial incentive to build the networks so long as consumer *demand* for the services is *unproven*.

Unproven consumer demand results in tremendous risk — a 'market risk' — for any company trying to develop a new product or service. Incompatible technologies, resulting in a fractionated marketplace and customer confusion, creates a second major risk, the 'standards risk'. Every company would like to be the first to deploy a successful proprietary technology, but no company wants to be the first to deploy an unsuccessful proprietary technology. The cost of doing so can be devastating. Yet a third risk is the 'asynchronous development risk', or the problem of different components of a system, such as hardware and software supplied by different companies, developing incompatibly, or on different schedules.

First Cities is a cooperative effort of more than a dozen diverse companies to reduce these risks and stimulate the development of an inter-operable broadband, interactive, network to the home. First Cities will do this by conducting a set of market trials, involving thousands of homes across the country, which will allow for real world tests of infrastructure facilities, technologies, and products and services. The trials will give participants early access to invaluable information about consumers preferences, and allow them to test the inter-operability of systems.

Each 'First City' will initially link between five and ten thousand homes. These homes will receive multimedia services, both commercial and public services. Commercial services might include movies on demand, customized newspapers made up of stories on subjects the consumer selects, games, and teleconferencing. Public sector applications in education could provide a whole range of new course offerings for rural school children, as the network allows them to interact with classes and teachers in other areas, or to access information from the library of Congress or the Smithsonian. A similar set of capabilities could launch a new generation of continuing adult education and foster broader retraining of our workforce to meet 21st century challenges. These services will be transmitted over fiber in some locations, and over the existing telephone infrastructure (twisted pair) or current cable tv infrastructure (coaxial cable) in others -- a fundamental principle of First Cities is that services available should not be dictated by the type of technology which delivers them. We are presently engaged in site selection, and we are planning to have the first trial site up and running in 1994.

In addition to MCC itself, fourteen companies participated in the initial planning phase of First Cities in 1992. They are: Apple Computer, Bell Communications Research (Bellcore), BTA, COMSAT, Corning, Hughes Training, Inc., Kaleida Labs (a joint venture of Apple and IBM), Kodak, North American Philips, Southwestern Bell Technology Resources, Inc., Sutter Bay Associates (a real estate and cable systems developer in northern California), Tandem Computer, TeleVideo Services, Incorporated (a developer and packager of multimedia information applications), and U S WEST.

On March 1, 1993, MCC initiated the second phase of First Cities, aimed at development and demonstration of the full, inter-operable architecture and its implementation in field trials. Membership is currently open, and discussions are underway with many companies in addition to those named. In addition to the current members and current industries, First Cities is interested in working with many types of carriers, including cable television companies, terrestrial broadcasters and cellular companies, financial services companies, and suppliers of multimedia information and entertainment products, among others.

INFORMATION INFRASTRUCTURE FOR BUSINESSES: EINet

Just as MCC is moving aggressively to bring the broadband information infrastructure to Americans in their homes, we are also engaged in an effort to bring the benefits of high speed networking to American business.

Over the last 18 months MCC has worked with over 100 companies, including AT&T, IBM, NCR, GE, as well as other consortia (Bellcore, NCMS, SEMATECH, SEMI, EPRI) to define a broadband digital commercial network that will allow thousands of enterprises to join together to buy and sell information, services, and products -- quickly efficiently, and completely electronically. The objective of the network is to allow businesses to operate with unconstrained ability and flexibility to create alliances, partnerships, and networks as competitive requirements demand them. To accomplish this requires a sophisticated level of networking. Enterprise Integration Network, or EINet, is the technology and software necessary to create at kind of network.

Why do businesses need this agile, flexible, information network? Consider the United States manufacturing sector. Manufacturing today accounts for 23% of U.S. GDP, 17% of American jobs, and much of the wealth creation in this country. Currently 30% of America's largest companies out source more than 50% of their manufacturing needs, and it is predicted that soon 60% of America's largest companies will contract out more than 50% of their manufacturing needs. In other words, a huge and important sector of the

American economy already relies upon a very complex network of suppliers to produce their goods efficiently.

In order to more effectively manage this complex system of suppliers, many large manufacturers are today creating their own information networks. Let me give two examples from our member companies. Boeing Corporation spends nearly $400 million every year to maintain and operate a sophisticated network linking its headquarters and manufacturing facilities with thousands of suppliers. Another example: The Limited uses its propriety network to respond to rapidly changes consumer tastes and to achieve extremely efficient distribution of clothing. Using an integrated network, Limited officials can quickly identify which items are selling and which are not, and rapidly find the supplier capable of delivering needed items at the best price in the fastest amount of time They can also use the network to identify regional variations in consumer demand, and quickly shift inventory out of slow moving stores into locations where the items are selling well. Using this system, the Limited is able to quickly limit their investment in slow selling items, and rapidly supply those products consumers want most.

But while current networks provide many important benefits to the companies that have created them, they suffer from some important limitations. First, these company specific networks are PROPRIETARY and CLOSED. To become a supplier to Boeing, hooked to the main procurement and production facilities electronically, can cost a small business as much as $100,000. The small business must acquire specific equipment and software to be compatible with the Boeing network. That up-front cost is an enormous barrier to participation. The result is that big business often can't reach the best small business partners, and small business can only afford to become a part of one supply chain if they can become a part of any at all. Moreover, proprietary and closed systems cannot easily communicate with each other; businesses on Boeing's billion dollar network cannot access information or participate in another company's network.

Think of the enormous benefits to business productivity and the country's economy brought on the advent of widespread telephone service. Then imagine how much more limited those benefits would have been if the

phone system wasn't universally linked; if companies in Kansas City could only communicate with companies and customers in Dallas and St. Louis, while businesses in Boston could only communicate with customers and businesses in Toledo. That kind of limited communication would have had certain benefits, but not nearly the same benefits as nationwide, or even international phone service. The same is true with networked communication among businesses; the more widespread the communication, the greater the benefits. Today, we have fairly widespread networking within industry segments: banking and financial services have wire transfers and ATM machines, large manufacturers are linked to their suppliers, and retailers have linked their stores, warehouses, and vendors, yet there is no communication among networks. EINet will create a universal communications link among all these businesses.

The U.S. government has already made substantial investments in widespread networks, first in the Internet, and now, the current effort to deploy a broadband digital network called NREN. EINet seeks to leverage that investment by creating an invisible layer on top of the NREN that allows existing proprietary commercial networks and any other business to communicate and do business with one another. EINet will link small, medium, and big businesses together to allow them to form virtual companies. It will also provide facilities to link together the existing local, state, and federally-funded agencies that work with small manufacturing firms on a broad range of technology, organization, and business issues (e.g., NIST Manufacturing Technology Centers, the Ben Franklin Partnership, and community colleges).

EINet brings to the electronic marketplace a set of common standards that enables network participants to do business with each other completely electronically without cumbersome and specialized software. EINet also provides the services necessary to do business electronically – directory services, security mechanisms, multimedia mail , and financial transaction capabilities. So instead of having one company make a large investment to hook up to only Boeing, that small company can offer their services to every customer on the network, at an affordable price. EINet thereby eliminates existing barriers to the most efficient production and distribution of goods

and services., and existing barriers to the enhanced competitiveness of U.S. industry.

THE ROLE OF GOVERNMENT

Both EInet and First Cities are programs to eliminate the current risks and barriers to a fuller deployment of a national information infrasture with the objective of creating a world of new opportunities for both individuals and industry. Each program is industry led and industry funded, but each has the potential to reap enormous benefits for American society. EINet promises to enhance the competitiveness of American industry and unleash a wealth of new opportunities for business and workers. First Cities will foster a widespread, commercially viable interactive network extending to American homes -- a network which will serve as the "horse" to carry public service applications in education and health care. These applications will blur the distinctions between resource starved schools and those with top quality materials and teachers, and urban areas with plentiful health care and rural areas with few doctors and no specialists.

Each of these projects has been propelled by the private sector, and it is our belief that the development of commercial networks should remain largely the responsibility of the private sector. At the same time, the government needs to make early, short term investments in these and other infrastructure efforts if they are to meet their full potential. With leadership and guidance from the government, risks can be reduced and the pace of development can be accelerated. Companies will be encouraged to invest even faster, services will be available sooner, and our nation will emerge as a dominate player on the world stage.

Programs to encourage research into high speed networking, such as HPCCI, and the NREN are an important first step in this direction, and we applaud them. Agile manufacturing and manufacturing technology programs within the Department of Defense, and manufacturing network initiatives within the Department of Commerce, are extremely important. Other programs proposed in legislation now pending, to encourage development of specific network applications in areas such as education, retraining, and health care,

also deserve support. But one caution -- we must not allow these various networks to be developed individually. Rather, there must be a guiding strategy.

There are however, a few points relating to the current information infrastructure effort I would like to bring to your attention for consideration.

First, for all the activity currently underway in the executive branch and in the Congress with respect to information infrastructure, there is still remarkably little attention being paid to the extension of the infrastructure to the home and to small business. The Departments of Defense and Commerce are actively engaged in the extension of the infrastructure among businesses, and among government institutions like the manufacturing technology centers. In addition, the current HPCC program and legislation now pending address the need to use an information infrastructure to link public institutions, like libraries and schools and health care facilities. Yet, current proposals do not explicitly charge any agency with the responsibility of overseeing or encouraging the extension of the information infrastructure to the home and small business

The extension of the infrastructure to small businesses and homes is vital if we are to realize the full benefits of the public and private investment in inter-operable, broadband digital networks. To accomplish this, we believe an agency should be empowered to perform three tasks. They are:

1. To support industry efforts to develop technical standards to assure inter-operability.

One of the most important, yet one of the most difficult tasks in creating complex information and communication networks is the development of standards. Standards ensure that different pieces of the network, and different networks, can work together and function effectively. Standards also protect consumers; Because there is a standard telephone jack, for instance, consumers are confident that no matter which phone they buy, it will plug in to the wall and enable them to place a call. Conversely, the lack of an early standard for the VCR resulted in a lot of people making

unfortunate investments in Beta-format equipment. The early establishment of standards, thus, saves money for both industry and consumers.

Standards can also be a challenge. The underlying technologies for these standards are continuously evolving; today's standard can be tomorrow's limitation (ISDN, DOS, VHS, MIDI, ethernet, eight track) What is needed is architectural flexibility, openness and inter-operability. These features give users the ability to mix-and-match products to meet their needs. Let me give an example.

First Cities is creating a digital world in which customers can send and receive information and entertainment using various delivery systems: a cable television network, a telephone company network, by satellite, by microwave transmission, by fiber, or by terrestrial broadcast. The consumer will be able to choose among these options, based on cost or quality preferences, much as they now can choose among long distance telephone service carriers. But just as consumers want one phone that works with every long distance carrier, multimedia networks should include applications and equipment that operate with different delivery systems. To create this consumer choice, First Cities participants must establish a technical standard which will enable one application -- say, a movie -- to traverse any one of these delivery mechanisms and end up looking largely the same when it arrives in the consumers home. The idea is to create a "jack" which all applications can "plug into".

The challenge now is to turn that concept into practical, cost effective standards and equipment. As envisioned, inter-operability will encourage competition and reduce costs to the consumer, yet it is not necessarily in the interest of any single company or industry to develop such capabilities. Therefore, it is important and appropriate for the government to provide funding for the development of inter-operable standards and technologies, before the marketplace develops with incompatible proprietary solutions all vying for supremacy. Industry is moving forward, the window of opportunity is swiftly closing. Action is needed this year, yet there appears to be no entity within the government with this responsibility. The supplemental appropriations bill includes $14 million for NIST to do standards work

relating to the information infrastructure, but none of the funds are focused on standards relating to the home market.

2. To develop public sector applications.

An interactive multimedia network provides myriad opportunities for distance learning, health care services, workforce retraining, environmental information dissemination and other public service applications. Such applications can be developed and maintained by the private sector, yet many of these applications will not be commercially viable; creation and support will need federal funding. We encourage you to make all these applications a specific charge of agencies doing applications development as part of the HPCCI and information infrastrucuture development, and to explicitly note the need to create applications for the home and small business.

3. To extend the reach of network based services to households and small businesses that would not otherwise receive them.

There will undoubtedly be a point in the development of any network at which it will become economically unfeasible to link areas of very low density, or businesses and communities unable to afford the equipment or services needed and desired. Given that the public service applications on such a network can be used to reduce the effects of economic and regional disparities, the government should provide support for such extensions of the infrastructure.

The final point I would like to make for the committee's consideration is this: government programs designed to assist in the deployment of the information infrastructure need to be agile, flexible, and capable of rapid responses. Although the deployment of a broadband digital network may seem to be a long way off, decisions are being made TODAY that will have a dramatic impact on the nature and quality of the broadband network, and on its costs and benefits to consumers.

One of the information infrastructure's primary benefits will be that it will allow businesses to reduce their time-to-market; the central element of

competitiveness in many industries today. Time to market is a function of an organization's agility, its ability to quickly respond to change. The success of any public-private partnership in the effort to deploy the infrastructure will depend on both partners ability to cope with the rapid pace of change and the rapid pace with which infrastructure developments are already occurring. Trying to develop inter-operable standards, for example, after significant investments have already been made in competing technologies, will be far more difficult and far more expensive, for industry, for the government, and for consumers.

The (Defense) Advanced Research Projects Agency's ((D)ARPA's) success in technology development is due in no small part to its ability to move more quickly than most federal agencies. DARPA's current efforts to streamline its contracting processes are further steps in the right direction. The National Technical Information Service's ability to enter into joint ventures, though still imperfect in practice, is another example of flexibility that could prove beneficial to the private sector, to the government agency trying to fulfill its mission, and to the federal treasury. These mechanisms should be further refined and expanded.

We recognize that the process of drafting, passing, and implementing legislation is a long one, by design. But the pace of technological change and the speed with which developments are taking place are creating a sense of urgency that must be acknowledged if the benefits of the information infrastructure are to be fully realized in the near term. I urge the committee to take this into account as it proceeds.

I appreciate the opportunity to make these comments before the committee today, and I am happy to answer any questions you may have.

Mr. VALENTINE. Thank you, sir.

Mr. Kerkeslager?

Mr. KERKESLAGER. Good morning, Mr. Chairman and members of the subcommittee. My name is Woody Kerkeslager. I am representing the Computer Systems Policy Project, whose members are the 13 largest computer companies in the United States. Thank you for the opportunity to appear before your subcommittee.

Today I will focus on three issues: our vision of the National Information Infrastructure, specific applications where the NII is particularly helpful, and the role of industry and government as partners in creating the enhanced NII. Today, the United States is the world leader in computing and communications, but we face increasing challenges. An enhanced NII will more effectively put our information technology to work for all Americans, and help us ensure our Nation's continued success.

There are many viewpoints on just what the NII is. Let me describe instead what the NII can do. The NII allows people, young and old, in rural areas and cities, to access information and to communicate with one another easily and securely using voice, data, image, video, or multimedia at any time, anywhere, in a cost-effective manner.

In addressing policy options for the evolution of the NII, we must start with people, the users of the infrastructure, to understand their needs first; then use information technology to address those needs. In brief, we must put people first, serving them with technology.

The National Information Infrastructure is far more than an electronic superhighway. In CSPP's vision, the enhanced NII integrates four equally important elements: computers and information appliances; interconnected, interoperable, commercially-provided communications networks; information resources from electronic libraries to distributed computer applications; and, finally, but not least importantly, the people who build, operate, and use all of these physical components.

There are many discussions today about who should build the NII. In fact, it exists and is evolving. Major components of the enhanced NII are in place. Many Americans already use computers and other information appliances, such as fax machines, at work and at home.

Numerous networks exist from low to high-speed, carrying voice, data, image, and video. Information services are available, and their number is growing at a rapid pace, and industry is rapidly developing and delivering even more exciting products and services.

But we face new challenges. Technology continues to evolve at a rapid pace. Some critical technologies are so expensive that industry and government need to work cooperatively to allow industry to re-establish a U.S. presence.

Many international markets are effectively closed to U.S. suppliers. A simple willingness to compete is no longer enough. While industry will continue to build the enhanced NII, government's roles as industry's partner are critical. We look to the government as a catalyst and supporter to create a shared vision for the NII, to create an enlightened regulatory and economic environment, to partner with industry in research in pre-competitive technology areas,

to fund application demonstrations and technology testbeds, to coordinate the many government agencies that are involved, and to work with industry to develop solutions to the complex policy issues that must be addressed. For example, Mr. Chairman, an issue you addressed earlier regarding electronic search warrants addresses the privacy and security issue. We also need to address intellectual property, ensuring competitive markets, and interoperability.

Let me now briefly comment on CSPP's focus and interest in the area of legislation. First, CSPP looks forward to working further with this subcommittee, and we welcome an opportunity to work with the full Science—House Science Committee—on legislation it plans to introduce to accelerate the development of the enhanced NII.

In response to the subcommittee's question on implementation of the High Performance Computing Act of 1991, CSPP will continue to support the High Performance Computing and Communications Initiative. We recommend enhancements to the HPCC program that could provide even greater advances in the development of technologies to help a range of social and economic problems.

We further recommend improving program management and increasing private sector input and participation. In our view, essential components of legislation to accelerate enhancements to the NII are funds for research and pre-competitive technologies, such as scalability of applications, interoperability across systems, easier-to-use human interfaces such as handwriting or speech and creation of a high-level interagency government and private sector body whose functions would include developing a national vision of the enhanced information infrastructure, and coordinating and overseeing federal activities. And we will support funding of demonstration projects which focus on health care, education, manufacturing, and government digital libraries.

We want to close with an endorsement of the efforts you are making, Mr. Chairman, to examine the state of the infrastructure and to re-emphasize what we consider an important point. The issue is not what the technology is, but what the technology can do for people. We should never lose sight of the fact that we must be driven by the needs, wants, and interests of the individuals, as expressed in the marketplace.

And we look forward to working with your subcommittee, the administration, and other members of the private sector to further the evolution of the NII and to deliver on its promise for improving the quality of life and our global competitiveness for the 21st century.

Thank you, Mr. Chairman and members of the subcommittee, for this opportunity to present the views of CSPP.

[The prepared statement of Mr. Kerkeslager follows:]

STATEMENT OF

Eliwood R. Kerkeslager
AT&T Vice President
Technology and Infrastructure

On Behalf of The Computer Systems Policy Project

PERSPECTIVES ON THE NATIONAL INFORMATION INFRASTRUCTURE: Vision, Applications, and Recommendations for Action

Before the Sub-Committee on Technology, Environment, and Aviation of the House Committee on Science, Space and Technology
March 23, 1993

Good Morning, Mr. Chairman and Members of the Sub Committee. My name is Woody Kerkeslager, and I am representing the Computer Systems Policy Project (CSPP). CSPP's members include the chief executives of Apple, AT&T, Compaq, Control Data Systems, Cray Research, Data General, Digital Equipment, Hewlett-Packard, IBM, Silicon Graphics, Sun Microsystems, Tandem, and Unisys. The CSPP CEOs work together to develop and advocate public policy positions on trade and technology issues that affect their industry, all high technology industries, and the nation.

I want to thank you for the opportunity to appear before this Sub Committee. Today, I want to focus on three areas: describing our vision for the National Information Infrastructure (NII); applications where the NII willl be especially helpful; and the importance of viewing the private sector and government as partners in delivering the NII.

While much of our work to date focuses on the domestic arena, we are ever aware there are essentially no longer domestic-only issues in information infrastructure.

America's Challenge:

America's standard of living is the world's best, and while we have much to be proud of in our achievements as a country, we cannot be complacent. It is clear that we face new and increasing challenges as we enter the 21st Century. We must find new and innovative ways to rekindle economic growth, remain competitive abroad, and create the high paying high-technology jobs that will enable Americans to maintain and enhance their standard of living. We must be more productive and innovative, finding ways to maximize the role and involvement of every American citizen as we move quickly and efficiently into the Information Age.

The United States is currently the world leader in computing and communications technologies, and an enhanced NII will put our information technology advantage to work for all Americans.

CSPP's NII Vision

CSPP is pleased that the vision we have articulated and continue to work toward has received both acceptance and endorsement by the Administration and is now being examined by the Congress. There seems to be no debate about what the infrastructure of the future should do but there is much work to be done in order to define the components of that infrastructure and to chart a clear and attainable course to its achievement. Our testimony elaborates on some of these points.

There are many viewpoints on what the NII is. Let me describe our view of the National Information Infrastructure in terms of what it can do. Through an enhanced NII, people, young and old, in rural areas and in cities, will be able to access information and communicate with one another easily and securely, in any medium or combination of media - voice, data, image, video, or multimedia - any time, anywhere, in a cost-effective manner.

What is Different about CSPP's Vision?

In addition, we propose a perspective which we believe that the Administration, Congress, industry and academia can share. Technology must serve the end users, must

make their lives better, more fulfilling, and more productive. The information infrastructure must function as a fully integrated system; it must be widely available and affordable. It is, after all, not what the technology is, but what the technology can do for real people--your constituents, our customers, America's citizens -- that make it valuable.

The NII will touch the lives of all our citizens from those who live in rural areas, large and small cities and suburbs, and who want and need access to information, work, and entertainment; to elderly citizens who may be isolated or alone; to our children who face great challenges as they grow up in the information age; and to our workforce, whose jobs change now, on average, 5-7 times in their worklife.

Put People First: In addressing policy options for the evolution of the NII, we must start with the users of the infrastructure -- understand their needs first, then use information technology to address their needs.

What is the NII:

The National Information Infrastructure is far more than an electronic superhighway. In CSPP's vision, the NII will integrate four essential and equally important elements:

1) interconnected and interoperable, commercially provided communications networks (carrying voice, data, video, broadcast, cellular, etc.)

) computers and information appliances (ranging from telephones and fax machines to servers, high performance computers, and supercomputers)

3) information resources(such as databases, applications, electronic libraries, printed materials, videos, and more;) and

4) the people who build, operate, and use all of the above

to create a whole new way of learning, working, and interacting with others.

Attaining our Vision:

This vision is attainable. In fact, major components and elements of the information infrastructure of the 21st Century are in place, or will be in the near term.

The competitive market has been successful in delivering a great range of products and services for consumers to use.

But circumstances are changing. Technology is evolving at an ever increasing pace. Some critical technologies, with long research cycles, are just too expensive for a single company to invest in. The marketplace for services and products is increasingly global in nature and many international markets are effectively closed to U.S. suppliers. A simple willingness to compete is not always enough.

Government and Industry as Partners:

While under our free enterprise system, the private sector has appropriately taken the lead in developing and deploying the distinct elements of the NII (networks, computers, services, and applications). Government's support and assistance have always been essential--and will be just as important as we create and add new products and services to continue enhancing the information infrastructure.

The U.S. has the most advanced and successful information infrastructure in the world, and we must all, in both the private and public sectors, remain committed to ensuring an enhanced NII to meet our nation's rapidly expanding information needs. Industry alone cannot successfully meet this challenge, however; we must have an effective partnership with government. It is clear that we share a common vision--our challenge now is to find the ways to work together to deliver on the promise and reality of the NII.

Legislation:

CSPP strongly supports the thrust of legislation to speed the development and enhancement of the information infrastructure. We look forward to working with this Sub Committee, and with the House Science Committee on legislation shortly to be introduced to augment the High Performance Computing Act of 1991. In particular, we support the concept of demonstration projects that focus on health care, education, manufacturing, and digital libraries as consistent with our recommendations for

accelerating development and deployment of the enhanced national information infrastructure.

CSPP recommends that any legislation to accelerate development of an enhanced NII, include: 1) funds for research in pre-competitive and generic enabling technologies for an NII, such as new techniques for managing the extremely high number of high, medium, and low speed users; interoperability of diverse systems and applicatoins; new, more intuitive human/computer interfaces, such as speech and handwriting; and 2) a high-level, inter-agency, government and private sector body to develop a national vision of an enhanced information infrastructure and to coordinate and oversee the federal activities.

And in response to the Sub Committee's question about CSPP's views of the implementation of the High Performance Computing Act of 1991, we offer the following comments. CSPP has previously endorsed the High Performance Computing and Communications (HPCC) Program as an excellent and necessary research foundation for the National Information Infrastructure. Our CEOs concluded that the HPCC Program is a significant and critical undertaking to advance research in high performance computing and networking technologies as well as increase the use of high performance computers to solve important science and engineering problems.

At the same time, the HPCC Program could provide a foundation for something more. If properly enhanced, HPCC research could advance the development of technologies to help solve a wide range of social and economic problems and improve the competitiveness of U.S. industry by providing the foundation for a national information infrastructure.

HPCC Program should remain a national research priority. The program's implementation could be more effective if improvements are made in the following areas: program management and increased and improved private sector participation.

1) Improve Program Management

The establishment last year of a new HPCC Coordination Office and the appointment of Dr. Donald Lindberg, the Director of the National Library of Medicine, Director was a critical step in the right direction. Dr. Lindberg is to be commended for his leadership in his new role and in his willingness to reach out to interested parties.

For the HPCC Program to move forward effectively, additional management authority is required to set program goals, assess progress toward those goals, and enable close interaction with other players in the delivery of the the information infrastructure.

CSPP urges the subcommittee, and other interested parties in Congress and the Administration to examine the charter, mission, and resources of the HPCC Coordination Office and assess whether a stronger management role for the office would increase the program's effectiveness.

2) Improve Private Sector Input

The research and technologies developed through the HPCC program have the potential to help provide the nation with the foundation for an infrastructure that will help improve the quality of life for all Americans in the 21st century. Investments in HPCC research can best be maximized through regular, ongoing input from the private sector. Currently, input and advice from industry can be provided informally through the Federal Coordinating Council on Science, Engineering, and Technology and through the individual agencies. The Federal Networking Council Advisory Committee provides a formal means for the private sector to provide input on private sector input to the HPCC Program.

The High Performance Computing Act of 1991 directs the President to establish an advisory committee on high performance computing that includes representatives of the research education, and library communities, network providers, and industry, who are specially qualified to provide advice and information on high performance computing. CSPP considers the appointment of such an advisory panel critical to provide the means for private sector input into the program. We are ready to assist in any way we can to facilite convening of such a group.

Finally, CSPP wants to comment on the role and importance of demonstration projects of the NII: CSPP recommends that demonstration projects that take advantage of available and near-term technology also be considered for funding through other legislative vehicles and government agencies. Today, for instance, wireless technology could improve a home health aide's ability to access remote medical information about the elderly patient she or he visits each day. The delivery of improved health care or even more effective health monitoring, could make a real difference to an elderly woman who can now live in her own home even though she has a serious health problem.

Pilot projects and testbeds are essential to demonstrate the applications of NII technologies in new areas, and to illustrate the benefits that they will make possible. Savings can be achieved through better management of health care data; we need more rapid development of standards; and we must address problems in scaling new technologies. We must bring together researchers from industry, government, academia, and the user communities to develop solutions to these and other difficult problems.

Brief descriptions of some of the improvements the nation may be able to achieve through an NII are:

Health Care

Today, America is facing a national challenge of improving the delivery of healthcare while addressing spiraling costs that are burdening our society and our individual citizens. An enhanced NII can offer new opportunities to improve the management and access to health care-related information and to reduce costs for processing insurance claims through electronic payment and reimbursement. Technology can reduce the barriers now created by distance--residents located far away from world reknown treatment clinics will be able to receive the benefits of the latest medical technologies and the services of the best medical experts and specialists, as their local physician consults electronicall -- while the patient remains in their familiar local setting.

Finally, easy access to information hy individuals in their homes on self-care and healthy lifestyle practices will enable people to better mange their own health, reducing the

number of visits to doctors' offices and hospitals, and increasing the likelihood that medical problems will be identified earlier. In our recent publication "Perspectives on the National Information Infrastructure", we reference on-line patient records, medical collaboration, and surgical planning and treatment as applications where an enhanced information infrastructure could help, in the near and longer term, to help to address the healthcare problems the nation is experiecing.

Education

An NII will be an essential tool for meeting the education challenges of the future, offering unprecedented potential for improving lives by making knowledge readily available and usable by all Americans. Education and lifelong learning applications such as on-line job training libraries; electronic libraries; virtual laboratories and field trips and collaborative learning would provide tools for addressing many of the learning needs the country is facing.

Intelligent Manufacturing

Increasingly, to stay competitive, companies of all sizes must be able to respond rapidly to customer demands for high-quality products at low cost. This requires manufacturing and design processes that are highly efficient and flexible to enable the shortest possible design, development, and production times. Companies able to adapt and apply the latest information and communications technologies to their manufacturing processes will have an advantage over their less innovative competitors in the future. The challenge, therefore, is to develop, deploy and apply the technologies for a manufacturing infrastructure that incorporates computing and communications technologies to support integrated development, engineering, and manufacturing processes, and to enable applications such as concurrent and distributed design, engineering and manufacturing; electronic commerce for manufacturing enterprises; and firtual design and manufacturing project .

Concusion:

A clearly defined and coherent vision shared by both the private sector and by public policy makers is needed to guide the development of an integrated and interoperable NII. This vision calls for shared responsibility; the private sector should develop and deploy the infrastructure, guided by the forces of a free and open market. For its part, government can accelerate the NII implementation by acting as a catalyst and a coordinator.

The goals of government leadership and enabling actions should be to demonstrate commitment, balance competition with needed cooperation, and ensure a level playing field for all. There should be an effort to consolidate diverse government players and agendas and to focus government sponsorship and funding of pre-competitive research programs and testbeds across the spectrum of the infrastructure components.

Finally, to ensure the deployment of the NII, CSPP has identified several important public policy principles which must be addressed by government and industry, working cooperatively. Some examples include include First Amendment rights, privacy, security, intellectual property, interoperability, competition, and carrier liability, as well as others.

By investing in the HPCC Program, the United States has already begun investing in the research for an infrastructure based on high speed networks, high performance computers, and on-line information. CSPP will continue to work with Congress and the Administration to implement our recommendations to improve the structure of the HPCC Program. However, we must now make a national commitment to take the next step to develop a new national information infrastructure that will provide us with the best opportunity to compete in the global economy of the future.

CSPP's CEO's are very pleased that the importance of the role of technology, and the commitment to achieve an enhanced information infrastructure has received the attention and commitment of President Clinton in his economic plan for the country.

They believe that more work can be done by both the private and public sectors: specifically:

1. Establish an NII Implementation Entity: Establish a federal entity to implement the Information Infrastructure Council's vision, plans, strategies, recommendations, and other directions.
2. Develop a Public Education Program: Request the National Research Council of the National Academies of Science and Engineering to develop, in conjunction with the private sector, a program to educate the general public about the potential benefits of an NII and the impact it will have on their lives.
3. Make Government Information Easily Accessible: The National Research Council should assess federal information collection and dissemination policies and practices and make recommendations on how such policies and practices should be changed to make public information easily available and accessible to citizens through the NII. The NII implementation agency should be charged with developing a strategy to implement the recommendations across all affected departments and agencies.

Most of the work for achieving an enhanced NII cannot be done by government. CSPP recommends that Industry :

1.. Continue Investments to Develop and Deploy an NII: U.S. industry must continue to work to develop and deploy the NII, including:

- deployment of interoperable communications networks;
- development of on-line databases and applications;
- development of easy to use computers and information appliances; and
- training people to design, develop, and use the various elements of the infrastructure.

2. Continue to Invest in Research and Development of Applications: Companies must continue independent and collaborative efforts to invest in research on NII technologies and development of new products and services.

3. Reach Out to Other Industries: CSPP is encouraging other industries likely to benefit from the applications made possible through an NII to join the effort to achieve an NII.
4. Promote NII Efforts: Industries should form a non-profit group to work with the National Research Council to promote an understanding and awareness of the benefits of the NII to end users.
5. Develop and Participate in Pilot Projects: Industry should undertake an effort to develop strategic plans and facilitate the formation of teams to design technology demonstration projects in health care, education and lifelong learning, and manufacturing.
6. Develop NII Goals and Milestones: The private sector will work with the Infrastructure Council to develop specific examples of accomplishable goals for an NII, with concrete milestones.

We look forward to working closely with this committee, and with the Administration and other members of the private sector to further the evolution of the NII, and to deliver upon its promise for improving quality of life and enhancing our global competitiveness for the 21st Century.

Thank you, Mr. Chairman and Members of the Sub-Committee for this opportunity to present the views of the CSPP.

Ellwood R. Kerkeslager
AT&T
Vice President - Technology/Infrastructure

Mr. Kerkeslager has extensive experience in the development and application of computer & communications technology in the U.S. information infrastructure. His early career at AT&T Bell Laboratories was focused on the development of computer controlled telephone switching systems and the automatic fault detection and correction hardware and software to allow commercial quality service to be achieved. His subsequent career has focused on the identification and application of new technologies to address user needs and in management of AT&T business unit/functional areas. Areas of expertise include Business Unit executive, Marketing, Finance, Network Planning and Engineering, Government Affairs and Technology development. In his present position Mr. Kerkeslager is responsible for developing policy for AT&T in all Technology/Infrastructure areas including Computers/Data Communications/Wireless/Video/Core Technologies. Mr. Kerkeslager is a graduate of the University of Chicago(MBA), New York University(MS-Electrical Engineering), Penn State University(BS-Electrical Engineering), Elizabetntown College(BA-Mathematics).

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Mr. VALENTINE. Thank you, sir.

I had my notes, I believe, from Dr. Cerf's testimony, maybe when you, Doctor, were talking about input that came to you when you undertook to poll the delegation, so to say. And did I understand you to say that some message came from Somalia to—

Dr. CERF. Yes, sir.

Mr. VALENTINE. —that part of that equipment should be left there? Is that right?

Dr. CERF. Yes, sir. One of the troops who is using the equipment in the conduct of our Operation Hope there suggested that it might be in the U.S. interest to help that country maintain and improve its telecommunications infrastructure by leaving some of the equipment in place and leaving it connected to the Internet. It happens to have been connected to the Internet by way of what's called MILNET, which is one of the Defense Department's communications systems which is linked to—in fact, was the progenitor of the Internet.

Mr. VALENTINE. Yes.

Dr. CERF. I thought that was a rather daring suggestion. I'm a technologist and don't know whether that's the right thing to do, but I convey that to you.

Mr. VALENTINE. Well, my thought was that, what would a country that can't feed its own citizens do with that type of equipment?

Dr. CERF. It puts them in touch, sir, with the rest of the world and, in fact—

Mr. VALENTINE. Yes, if they knew how to run it, or if it got into the hands of the right people. I could see it on the black market or some place else, but I wish that that were true. I mean, I wish that we could expect that the utilization of that—maybe so. I mean, maybe so, but I—what we are talking about here is a step beyond a canal system, and we're dealing with people there that either don't have the will, or the ability, to be sure that their own people—you know, to help get supplies in to feed starving children.

Anyway, you recommended, Doctor, that the government encourage development of this ISDN, these services. And some argue that the lack of development of common standards by our commercial network operators has retarded the introduction of this new technology. I'd like to ask you if you share this concern. And others argue that this is an old and antiquated technology, and the fact that no common standard was developed has caused us to leapfrog over that. What do you say? Do you agree or disagree with those statements?

Dr. CERF. I think that in the case of ISDN, it took a very long time for agreements to be reached about the technology to begin with. That work was carried out in an international setting.

Second, it wasn't clear exactly which applications would drive the deployment of the technology. And so the telecommunications companies have put it into service in fairly cautious ways. Recently, there was an attempt to bring that capability much more visibly into operation through something called Trip '92, which is a Bellcore and other telecommunications companies' initiative. They carried out something in November called Golden Splice, which is reminiscent of the golden spike linking the railroads together.

I actually feel very ambivalent about the ISDN technology. We know that there are technologies which exceed its capability dramatically, and we're experimenting with those in billion-bit-per-second networks today. On the other hand, it's certainly an improvement over analog communications. And for those of us who suffer trying to use data communication systems through analog pipes, 64-kilobit or 128-kilobit capacity would be welcome.

It seems to me that for residential communications, for instance, that such a capability might be quite helpful. I think, for businesses, their needs are already in excess of what the narrowband ISDN can deliver. They're running their networks internally at 10 megabits and higher. So we probably need to move, as quickly as we can, toward the more broadband capabilities, in order to give business what it needs.

Mr. VALENTINE. Dr. Green, in your written—your written testimony refers to a high-speed fiber optic link among medical research and teaching centers in New York State that will enable researchers to transmit X-Rays from a cancer facility to Brookhaven National Lab, to physicians at a university hospital. Can different cable systems be linked together so as to enable X-Rays to be sent to physicians elsewhere?

Dr. GREEN. Yes, sir, the answer is yes, and what we are doing is advancing the architecture still further by interconnecting cable systems within regions; and that is detailed in the testimony, too. I didn't really have time in the oral statement, but the general plan is to provide a fiber loop interconnecting cable systems which provide a high capacity path, which allow shared services and economies of scale in the operation of the cable system, but, even more importantly, it allows an interconnection point to other networks.

And, for example, the Internet, you can access the Internet through some cable systems; in Cupertino, California, for example. So even the cable systems are part of the Internet operation.

And I think with respect to the interoperability of cable systems, which in the past has been a problem because cable systems have used different technologies, but over the last few years we've been able to bring about a common direction and a common architecture which cable systems are now adopting. So, you see, these regional centers occurring in places like New York and the Bay Area, Seattle, Denver, and, you know, in many other sites around the country—so cable systems are adopting this kind of interoperable regional concept.

Mr. VALENTINE. I, with my background, can't decide what this would do to the cost of the delivery of health care services. I can see that if you had, through this marvelous system, access to the ability of some noted national physician to read an X-Ray, you could do it this way, I suppose, and save lives. But what would that do to the cost? Would it take the place of the cost of having to transmit—to take a patient from Duke University Medical Center to Rochester or to Harvard to some place of that kind? And what in the world would it do to the standard of care and medical malpractice cases?

Dr. GREEN. Well, I think there's a lot of room for the use of communications technology in the medical services. Clearly, one topic that we've talked about here is the transmission of images, and de-

tailed images, to centers where they can be interpreted or processed. There's also there, I think, the issue of medical records, and then you begin to address some of the issues that you mentioned of security and privacy, which are extremely important, and I would agree with Dr. Cerf. Those elements of protection must be built into the information highways.

But I think the idea is to be able to bring economies of scale in processing and accessing and storing records, to bring quick access to information which can be used in interpretation of various medical procedures, and to bring services to people who would now not be able to reach them in time to take advantage of those kinds of services.

I think we have to—there are lots of issues and technological issues that have to be addressed in the interface, and I think you very correctly raised those. I'm not sure how this would all work. I think the process is developing a technology, and then developing the interfaces that will be needed to provide those kinds of services.

Mr. VALENTINE. You see, one of the things that we face in the beginning of the effort to do something about the delivery of health care in this country—everybody admits that it's the best in the world, but, you know, to go—to maintain a continuous system where if you go to a small, rural hospital now and stay overnight, you've got a bill of $3,000. And we are confronted—everybody who mentions the problem, they tick off the contribution that, either real or imaginary—let me say that to cover my tail a little bit—that the pharmaceutical companies make the problem and the insurance companies make a problem and always bring in the trial lawyers and the threat of lawsuits.

And, you know, I just wonder, when we didn't have such expensive system, we didn't have much care. And we didn't have—we have, you know, I suppose, worked ourselves into a situation where we have created all kinds of financial problems. I just here wonder, as an old country lawyer, when all those questions are asked, and not one who specialized in malpractice litigation. But when you think about that little hospital in an isolated area protected to some extent, that doctor is, by what is the normal standard of care in that area, and when you all of a sudden say that, by placing that patient on an ambulance and taking him 40 miles maybe, or even less, or maybe this capability is right there in the hospital, that you now have to have a whole new ball game because maybe the doctors that you had in that area were in the bottom 10 percent of the class, but you've got access to the guys in the top of the class.

[Laughter.]

Anyway, that's to work out—maybe I'll retire from Congress in time to benefit by this.

[Laughter.]

Dr. Kushner, you—and I'm just about to the end, Mr. Rohrabacher, so you can take over—in your testimony you made a strong plea for the government to provide funding for the development of interoperable standards, and so on. Would you tell us a little bit more about it? What do you see that government funding for? For example, are you encouraging that the government establish, or encourage the establishment, of standard-setting bodies?

Dr. KUSHNER. There already are a number of standard-setting bodies. I mean, as the gentlemen on both sides can attest, there is no lack of standards and standard-setting bodies. In many cases what we're really interested in is being able to ensure the interoperability or the full connectivity in much the same way that Dr. Green described and Dr. Cerf described previously, full connectivity amongst the different systems.

When you, in fact, are looking at the choice, if we can go back to the example that I used about bringing a variety of different services to the home, if you're looking at the choice between fiber to the home, or cable to the home, or twisted pair to the home, or wireless to the home, and then there's an entire network that exists behind that, there are a number of different interface points, a number of different standards that have been developed to be able to promote those interfaces. And being able to ensure the full connectivity on the hardware side and ensure the connectivity so that, as Dr. Cerf mentioned, the bag of bits problem does not occur, so that you, in fact, have software when it is sent over the network that has some knowledge about, or is determined about, where it is going, and when it arrives at its location it is not just random characters but actual content and information—so being able to put—being able to support—those types of initiatives which exist both within some of the industry consortia, ourselves and CMS, the Electric Power Research Institute, all of whom are working in this area, the National Institutes of Standards and Technology, being able to look at other groups that are involved peripherally in setting standards, as well as working with many of the international bodies, we believe that being able to promote the interoperability to be able to support providing consumer mix-and-match choice, so that anything that a consumer wants to be able to do, if they want to be able to use one system linked to another they can do so, we think that is a good thing.

Mr. VALENTINE. Unless we are very careful and very wise, what's all this going to do to small business in this country and to the traveling salesmen? Maybe some of this is good, but, I mean, you—maybe all of it is, but you talk about, we are talking about large companies who have money to spend that will be able to have access to suppliers, manufacturers, and be able to move—keep up with trends and be able to move merchandise into where they can retail it. Is that going to be kind of like—is the effect going to be like Wal-Mart on the small hardware stores throughout the United States?

Dr. KUSHNER. We hope not. I'd like to be able to respond to that. Part of what I included in my testimony was another impassioned plea, if you will, to being able to provide the information infrastructure to many of those small businesses and to the homes that otherwise would not be able to be connected and not be able to participate and benefit.

We see that, even at the present time, as I mentioned the example with Boeing and The Limited, in many cases most of their vendors are small businesses.

Mr. VALENTINE. But, see, you mentioned how much they spent, which—

Dr. KUSHNER. I mentioned how much they spent, in the case of Boeing, to maintain and operate their own internal proprietary network. There are similar figures associated with many other of our members, and there are numerous examples right now, even in the case of Wal-Mart, to be able to create some level of electronic network.

The problem that we have is being able to gain access to it, the cost associated with small businesses being able to enter onto that network, and, of course, the ability to be able to have the right types of connectivity, the interoperability that was mentioned previously, and the right types of applications software, so that as the market needs change, or in this case, the demands of their customers—maybe a Boeing, or a Limited, or in the ultimate case the consumer—they have the ability to make the design changes and the flexibility to be able to get their products manufactured and shipped, to be able to respond to those market changes.

Mr. VALENTINE. And, Dr. Cerf, you say exactly the opposite result will occur.

Dr. CERF. Yes, sir. I think that, in fact—

Mr. VALENTINE. Not from what he said, but—

Dr. CERF. Well, no, no, I'm not disagreeing with what Mr. Kushner is saying, but your concern was, will the small businessman be adversely affected by the evolution, creation, and instantiation of information infrastructure, and I think that the small businessman is vastly enabled by this, the existence of such an infrastructure.

What this does is lower the barriers to entry into services on the network. It reduces the amount of effort that any one company has to put into injecting its new products and services into the system, making it visible and accessible to the marketplace. So, if anything, the investment in creating information infrastructure creates a far more level playing field and lets our creative juices in the business community focus on the creation of new products and services and less on investment in infrastructure, private infrastructure. So I think, in fact, it's a great enabling engine.

Mr. VALENTINE. Thank you, sir.

Mr. Kerkeslager, your testimony—and this is my last question—you mentioned the importance of government and industry working together cooperatively to develop public policy principles which include security. And my note says, "There appears to be some tension between private business and certain government agencies." I know from my congressional experience that there is tension in that area. I was on another subcommittee when we sought to—when we got into this business, and were confronted with what I hadn't had the occasion much to think about in my life; that is, the needs of—the security needs of a government and the security needs of a bank.

Would you—how do we resolve this? I found that it was quite a frustrating experience. I could understand both points of view. Would you comment further on that?

Mr. KERKESLAGER. Thank you, Mr. Chairman. That's a very to-the-point question and a very difficult issue.

The principle upon which I think the answer has to be addressed is one of the varying needs of the users in the community. Consum-

ers at home, and individual small businesses, large businesses, banks, the government agencies have a variety of needs which range from slow-speed communications to very high-speed communications. They all need to be addressed within the National Information Infrastructure. That is why there is not one answer for what kind of network, what speed of service, and what technology is appropriate.

The same issue applies to security. Some level of security is appropriate for a casual conversation of two individuals in which you may use a portable telephone with very little security and there is no problem with that. If you are getting into a personal conversation, or if you're getting into business with secure information, you would like at least a rudimentary form of security which makes it difficult for someone to listen in or to access your databases. When you get into secure banking operations in which financial transactions could be modified, when you get into government, certain government operations, you need very high levels of security.

If we recognize those different needs, I think we should be able to reach an agreement between—a balance between the needs of the players, the security needs of the government, the security needs of business, and the way with which we provide the encryption, decryption, et cetera. I think there are answers to be found there.

Mr. VALENTINE. Thank you, sir.

Mr. Rohrabacher?

Mr. ROHRABACHER. That last answer fit into the question I was going to be asking about the intellectual property protection, and also the point that Mr. Cerf made about the need for an examination of our export policies with COCOM and the export of RSA and DES cryptography technology.

I understand that we are doing or we have instructed—who was it; what was the agency that we instructed to look into—the NSA to look into this, is that it? I would appreciate it if you would like this committee to write a letter to get the NSA off their hind ends, and get moving on this study they were supposed to do. If you'd like to write us a letter that would then permit us to write the NSA and ask where it stands on an intellectual basis—

Dr. CERF. I'd be happy to comply, Mr. Congressman.

Mr. ROHRABACHER. Okay, that would be very helpful.

[The material referred to follows:]

Dr. Vinton G. Cerf
3614 Camelot Drive
Annandale, VA 22003-1302

11 April 1993

The Honorable Timothy Valentine
Committee on Science, Space and Technology
Subcommittee on Technology, Environment and Aviation
House of Representatives
Rayburn House Office Building

Dear Chairman Valentine:

I recently had the honor of testifying before the Subcommittee on Technology, Environment and Aviation during which time Representative Rohrabacher (R, California) made the request that I prepare correspondence to the committee concerning the present US policy on the export of hardware and software implementing the Data Encryption Standard (DES) and the RSA Public Key encryption algorithm (RSA).

As you know, the DES was developed by the National Institute for Standards and Technology (NIST) in the mid-1970s, based on technology developed by International Business Machines (IBM). The details of the algorithm were made widely available to the public and considerable opportunity for public comment on the technology was offered. In the same general time period, two researchers at Stanford University (Martin Hellman and Whitfield Diffie) published a paper describing the possible existence of mathematical functions which, unlike the symmetric DES algorithm, could act in a special, pairwise fashion to support encryption and decryption. These so-called "public key algorithms" had the unusual property that one function would encrypt and the other decrypt -- differing from the symmetric DES in which a single function performs both operations. The public key system uses a pair of keys, one held private and the other made public. DES uses one key which is kept secret by all parties using it.

Three researchers at MIT (Rivest, Shamir and Adelman) discovered an algorithm which met Hellman and Diffie's criteria. This algorithm is now called "RSA" in reference to its inventors. The RSA technology was patented by Stanford and MIT and a company, Public Key Partners (PKP), created to manage licensing of the RSA technology. A company called RSA Data Security, Inc., was also

Home: +1 703 573-1965, 573-7125 TDD: +1 703 573-3104 FAX: +1 703 560-4004
Voice/TDD Relay: 1 800 828-1140
Office: +1 703 620-8990 TDD: +1 758-5913 FAX: +1 704 620-0913
MCI Mail, vcerf/1050002 Internet: vcerf@cnri.reston.va.us

formed, which licensed the technology from PKP and markets products to the public based on the technology.

The current policy of the United States places DES and RSA technology under export control. Because cryptography falls into the category of munitions, it is controlled not only by the Commerce Department but also by the State Department under the terms of the International Traffic in Arms regulations. Despite the public development of both of these technologies and their documented availability outside the United States over the last 15 years, US policy has been uniformly restrictive concerning export licensing.

As the United States and the rest of the world enter more fully into the Information Age in which digital communications plays a critical role in the global infrastructure, the "digital signature" capability of public key cryptography is a critical necessity for validating business transactions and for identifying ownership of intellectual property expressed in digital electronic forms.

Registration and transfer of intellectual property rights in works which can be represented in digital form will be cenral factors in the national and global information infrastructure. A number of parties are exploring technical means for carrying out rights registration and transfer, making use of public key cryptography as a basic tool.

In addition, there is a great deal of current work on electronic mail systems which support privacy by means of encryption and support authenticity by means of digital signatures. One of these systems, developed in the Internet environment I mentioned in my testimony, is called Privacy-enhanced Mail (PEM) and makes use of DES, RSA and some other special "hash" functions which are integral to the production of digital signatures.

For these various systems to be compatible on an international basis, it would be very helpful for the cryptographic components to be exportable on a world-wide basis. A number of vendors make produces relying on these technologies within the United States but often find it very difficult to engage in international commerce owing to the export licensing required for these technologies. Ironically, the technology appears to be widely available outside the US and also outside the COCOM countries, so US firms face both competition outside the US and export inhibitions in their attempts to develop worldwide markets.

There are many valid national security reasons for limiting the export of cryptographic capabilities, since these technologies may aid an opponent in time of war or other conflict. Perhaps just as important, US intelligence gathering capability can be eroded by the availability of high grade cryptography on a

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Voice/TDD Relay: 1 800 828 1140
Office: +1 703 620-8990 TDD: +1 758-5913 FAX: +1 704 620-0913
MCI Mail: vcerf/1050002 Internet: vcerf@cnri.reston.va.us

worldwide basis. Recently, it has also been alleged that the world-wide availability of cryptography would also seriously impede US drug enforcement and anti-crime efforts While these reasons seem sufficient, many have pointed out that the widespread accessibility to the detailed specifications of DES and RSA and availability and existence of software and hardware outside the US have long since done whatever damage is going to be done in respect of warfighting, crime or drug potential. This line of reasoning leads to the conclusion that our policies only inhibit legitimate commerce, but have little impact on the other concerns expressed.

As in all such controversy, there is often some truth on both sides. The National Institutes of Standards and Technology (NIST), has offered alternative digital signature capability. Technical assessments of the alternative have turned up weaknesses, in the opinions of some experts. There is not yet an alternative to DES, unless it is to be found in NSA's Commercial Crypto Evaluation Program (CCEP) in which NSA proposes to provide algorithms which are implemented in hardware by industry and made available for civilian use As I understand this program, NSA does not intend to release any details of the algorithms, leaving open questions about the nature and strength of the technology. Some experts will persist in the belief that such offerings have weaknesses which are deliberately built in and hidden (so-called "Trojan Horses") which will allow the agency to "break" any messages protected by this means.

The critics complained loudly that the reasoning behind the design of certain parts of the DES algorithm (specifically the "S-boxes") was never made public and therefore that the algorithm was suspect. In fact, the DES has proven to be very strong - indeed, it may be that very fact which makes it so unpalatable in some quarters to permit its unrestricted export. It may be that the CCEP technology offered is satisfactory, but this is hard to tell without knowing more about its provenance.

Presuming the wide availability of both DES and RSA technology, it seems to me appropriate and timely to re-examine US export control policy regarding these two algorithms In all probability, any such review will require some classified testimony which will have to be heard in confidence by cleared members of your committee I sincerely hope that the outcome will be favorable to use by US industry in international commerce, but even if the outcome results in continuation of present policy, it is timely to make such a review, in my opinion.

Sincerely,

Vinton G. Cerf

Home: +1 703 573-1965, 573-7125 TDD: +1 703 573-3104 FAX: +1 703 560-4004
Voice/TDD Relay: 1 800 828-1140
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Mr. ROHRABACHER. I am a former journalist, and I know this bit about a lot, but I don't know this much about anything, and I have really learned a lot today, I'll have to say. And I will try my very best to maneuver my way through this subject area.

One last note—and I do have in front of me a report by the Progressive Policy Institute talking about how the different—basically, we can use the electric companies involved to be involved in this whole effort. And I have one last area I'd like to focus on, and that is just to talk to Mr. Green about the cable companies' potential. And I would hope that the cable companies—I know there are some cable company operators that, when they look at the changes that are going on, they say, "oh, my gosh, there's going to be competition to our being able to make a profit in supplying entertainment to our customers." And I would hope that the cable companies, like the electric companies and others, start looking at the potential for their competition in the providing of information and in the whole communications arena, rather than simply looking at themselves as a means of entertaining the public and worrying about somebody competing with them in that.

Cable is in a unique position. There are small companies around the United States who are involved in this industry who have tremendous potential, and I would hope that your industry moves forward. Unfortunately, many cable companies, as we know, were established by people who simply were granted monopolies in their local area, which does not lead to entrepreneurship. Hopefully, those people within your industry who are entrepreneurs and understand the potential will move forward very vigorously with these new opportunities. Please feel free to comment on that.

Dr. GREEN. Thank you. I believe that most cable companies, and certainly the majority of cable companies, recognize they are in the telecommunications business not in the entertainment business. And I think one of the fortunate aspects of that has been the ability to transfer technology. That has occurred in the area of fiber, and it's occurred in the area of digital compression. Both technologies really advantage cable systems, and, in particular, the smaller systems.

So I would pass on to you that, at least at the view that I see of the cable industry, it is very progressive in its application of new technology, and its interest in pursuing the new telecommunications revenue streams, of being able to interconnect people for multimedia services, of, as I mentioned in the testimony—

Mr. ROHRABACHER. Right.

Dr. GREEN. —doing a lot of experiments vis-a-vis wireless telephony, using the cable network to pick up the wireless signals, and transfer it back to the public switch network. And there's a whole array of opportunities, and I think that you will see the cable companies coming forward to present that view and offer these services.

Mr. ROHRABACHER. Well, there's always whether the glass is half full or half empty, and, as the chairman noted, there will be complications to this information network. We will have to—and it will be—there will be complications that the government will have to make definitions.

On the liability question, it was just fascinating that the chairman brought that up and that was true: we're going to have to define the level of liability here, and that's the job that government has. And that's our role. And I—just when we talked to Mr. Cerf here about making sure we define exactly what the intellectual property rights are and make sure that the technology is available to help protect and limit those areas where people can intrude on each other's information—so, Mr. Chairman, I thank you very much for calling this hearing and I've enjoyed the testimony of our witnesses today.

Mr. VALENTINE. Thank you, sir.

And, Mr. Bartlett, I thought I was going to be able to resist this, but I cannot. Mr. Rohrabacher says he knew a little bit, but not this much, but he always wrote this much [indicating], some say, not me.

[Laughter.]

Mr. Bartlett?

Mr. BARTLETT. Thank you very much. I have just two quick questions.

Dr. Cerf, you mentioned this elaborate highway system that we're building with fiber optics across the country, and you mentioned also the necessity of developing standards and formatting and software and integration, so that we can make the most effective use of this system. In your judgment, which of these two areas, the system itself or our ability to use the system, is going to be limiting in the utility of this system in our economy?

Dr. CERF. If I am interpreting your question correctly, let me say that the hard part is not getting the basic system deployed, getting the equipment to move bits from one place to another. These are pretty well-understood technologies. There are cost questions, and questions about when and how they should be deployed, and who pays for things, but those are not technical questions. Those are important economic ones.

But the thing which makes this is a useful system is going to be the software in the computers that drive it, or whose applications are being implemented and reached through it, or whose services are delivered through it. It's the creativity of that process which is most critical.

Fortunately, I think we have in the United States the most amazing array of intelligent, bright, and creative people, thanks to our university system, who in that environment have been able to take almost any new technologies and turn them into highly useful applications, and they leave that university environment to go into industry, and they often create industry.

So, in some sense, I think that it's not hard necessarily to create that software. What's hard is making sure that all of the software that does get created will interwork satisfactorily. It's not helpful if I use this machine to do 90 percent of my work; I want the results of that work to be accessible to you and to your colleagues, who I hope use similar kinds of equipment, or you will eventually. The problem is if the output of my work is not accessible to you, not useful to you, then it's wasted effort. So if the infrastructure is going to pay off, it's going to pay off because we figured out how

to make sure all the software understood the ability to exchange information in an understandable way. That's standards.

Mr. BARTLETT. Thank you. You mentioned the need for creativity here. If we allow that government is probably not the most creative institution in the world, what can government do to make sure that this creativity is appropriately developed and integrated?

Dr. CERF. Actually, I would debate whether government lacks creativity. In part, I say this because I once served in the government and so I wouldn't want to cast any aspersions on that past service. Frankly, the government has very interesting and good ideas. The Defense Department, ARPA for example, has stimulated the creation of whole new industries simply by investing in high-risk, high-technology ideas. And I daresay that one will find this to be true of some of the other initiatives stemming from the high performance computing and communications initiative.

I think it's that kind of thinking which is taking place in the legislature, which is conducted and carried out in the Executive branch, that in fact has stimulated a great deal of creativity. The idea is not necessarily that you have figured out how to do it, but rather that it should be done. And the government, in fact, is in a very good position to lead by setting goals, taking ideas and challenging the private sector, and the research and academic community to meet some of those objectives.

Mr. BARTLETT. You would encourage government, then, to encourage and fund leading-edge technology that would provide spin-offs in this area?

Dr. CERF. Yes. I also would encourage government to look to leveraging its expenditures by working together with industry. I have been extremely impressed by the way the National Science Foundation has created something called cooperative agreements, which it engages in with industry. What this typically means is we'll put in a little and, industry, you put in more. They have achieved massive leveraging in the high bandwidth computing work that CNRI is involved in by putting some small amount of money, $16 million over three years. The industry component of the gigabit testbed project has got $200 million or more in industry contributions in-kind, availability of fibers, switching technology, and the like, which simply can't be paid for because it's all experimental and "researchy." So the government can, in fact, leverage its dollars very, very effectively in this business.

Mr. BARTLETT. Mr. Chairman, do I have time for one question to Dr. Green?

Mr. VALENTINE. By all means, yes, sir.

Mr. BARTLETT. Thank you. Thank you.

I had the privilege some 20 years ago—

Mr. VALENTINE. Let me encourage you to take whatever time you need. There's just you and me.

Mr. BARTLETT. Oh, thank you. I don't want to hold everyone here too long.

I had the privilege some 20 years ago of working eight years for IBM, and I had the great privilege, while working there, to be chosen to serve on a corporate task force looking at what information handling might be able to do in the whole medical area. With all

the technology that has developed in the last 20 years, the prospects are even more exciting than we could envision at that time.

Standardized electronic billing, of course, and all the information handling is something very obvious. You, very correctly I think, pointed to the potential for digitizing information, as we now do in a CAT scan, and now digitizing and sending that information and the consulting that is done without having to move physically, and so forth. And these are all very exciting things.

I think that this will be best accomplished with an appropriate competitive environment. I know that the cable TV industry has been recently regulated. And I want to ask you if you think that—well, first of all, if you support competition by cable doing some of the things that telephone does and telephone doing some of the things that cable now does; that if competition with telephone companies, with satellite dishes that perhaps linked several homeowners when they felt that the cable TV company was charging them too much, that seemed to me to be an alternate solution to their problem. Would you think that competition among these several entities could do two things: one, lessen the need for government regulation and, secondly, encourage increased development of the medical software systems that will help bring down the cost of health care?

Dr. GREEN. Well, I think that—well, of course, what we're seeing is a change in the availability of technology. And, as you very correctly mention, that the technology that's becoming available is now much more powerful than the technology that we had before. And those technologies, I think, are affecting businesses. They're obviously affecting the cable business because, as you also mentioned, the delivery of multi-channel entertainment service now is going to be available by other means, certainly by satellite, and the telephone companies are offering that, and so on. So I think that the environment is going to become much more competitive. I realize that is debatable, but, nevertheless, from our perspective, we certainly see the competition developing toward our core business.

I believe that the competition in applying new technology, as you mentioned, to these new areas in new services is going to be very important for the cable industry, and other industries as well. And I think that the ability to—we talked this morning about high definition television. Well, high definition television is certainly an entertainment medium, but it also has a lot of implications in other areas: manufacturing; it has implications certainly in medicine and those areas.

So I think that an industry's ability to be able to develop and apply technology to these problems is going to be extremely important, not only in the business sense; but in terms of producing lower costs for delivery of these kinds of services.

So I guess, to face your question more directly, I see technology being unbiased in being applied by a wide variety of industries toward the goal of producing the economies of scale that will be important for not only the medical area, but many other areas as well.

Mr. BARTLETT. Thank you very much. Your answer seems to imply that we need to regulate only where competition can't effect

the necessary balance, and I think that's a goal that most people support.

Thank you very much for your answers and your presentations.

Thank you, Mr. Chairman.

Mr. VALENTINE. I thank the gentleman from Maryland.

I want to thank the members of this panel and say a word also about the preceding panel. We do appreciate your testimony. I regret that more of our colleagues were not able to come here, not just those on this subcommittee and committee, but I think that what you have put on the record here today is a significant and very meaningful contribution toward what we in the Congress are about, or certainly should be about, helping to lead the way to restore this country to its position of preeminence in the world.

Well, we're about to adjourn, but let me make this statement before we do leave here. We will continue our examination of telecommunications and high performance computing issues on Thursday, March 25, the day after tomorrow, in this room. Now this hearing will begin at one o'clock p.m. This represents a change from our previously published schedule. So those of you who are interested in this, please come and join us the day after tomorrow, Thursday, March 25, at one o'clock, not earlier, in this room. Help us spread the word as to that change.

With that, the subcommittee will stand adjourned.

[Whereupon, at 11:54 a.m., the subcommittee adjourned, to reconvene Thursday, March 25, 1993, at 1:00 p.m.]

TECHNOLOGY POLICY: INFORMATION INFRASTRUCTURE [INFORMATION SUPERHIGHWAYS AND HIGH PERFORMANCE COMPUTING]

THURSADY, MARCH 25, 1993

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON TECHNOLOGY, ENVIRONMENT AND AVIATION,
Washington, D.C.

The subcommittee met, pursuant to recess, in Room 2123, Rayburn House Office Building, Hon. Tim Valentine [chairman of the subcommittee] presiding.

Mr. VALENTINE. I wonder if I could have your attention. We'll try to get started.

The subcommittee meets today to continue its examination of technology policy and the President's program to encourage the rapid development of an advanced, high-speed, broadband information infrastructure for the United States. On Tuesday, I provided a brief sketch of a number of the themes in the President's program that we are examining, and I'll not repeat that here this afternoon, but my statement is available for anyone who might be interested.

Today we hope to elicit more testimony on the implementation to date of a High Performance Computing and Communications Program established by the 1991 High Performance Computing Act. We also hope to receive the views and recommendations on Title VI of S. 4, which provides federal support for research and development on applications of high performance computing and high-speed networks for education, health care, manufacturing, and building digital libraries.

We are privileged to have with us Dr. Donald Lindberg, who is director of the National Coordination Office for High Performance Computing and Communications. We will also hear from Dr. Sidney Karin, who is director of the San Diego Supercomputer Center, and Mr. Jeffrey Kalb, who's president and chief executive officer of MasPar Computer Corporation of Sunnyvale, California.

We will continue our examination of other components of a national information infrastructure and its importance to our economy.

We will be hearing from Mr. Salim Bhatia, who is president of BroadBand Technologies, Inc., in Research Triangle Park, North Carolina. BroadBand Technologies is a small business tele-

communications equipment vendor, and Mr. Bhatia and his firm are engaged in testbed activities with our Regional Bell Operating Companies. And since he is my constituent, or has, I hope, plans to move into my district with his family, I say to him a special word of welcome.

We will—I didn't know they had written some stuff in there for me to say. I adlibbed that, but I got it mostly right.

We will receive testimony also from Dr. Stephen Gage, who is president of the Cleveland Advanced Manufacturing Program.

This subcommittee has proposed legislation, H.R. 820, which contains programs intended to revitalize the manufacturing base of our nation. And of some interest to you perhaps, we got into a scheduling situation. We are—have been until a few minutes ago—about the business of marking up, which is an expression used by politicians in this place to mean that we convert the legislative handiwork into the type of thing that the chairman of the subcommittee thinks it should be. And we will go back to that work at three o'clock and continue that endeavor, which is going very well.

The manufacturing model for the next century is "agile manufacturing," which involves short design cycles, production in small lots, and rapid reconfiguration of product lines.

I will not trespass any further on the time of these witnesses who have come here at some expense and great distance, and put the rest of my prepared statement in the record.

[The prepared statement of Mr. Valentine follows:]

OPENING STATEMENT

THE HONORABLE TIM VALENTINE
HEARING ON NATIONAL TECHNOLOGY POLICY: TELECOMMUNICATIONS AND HIGH PERFORMANCE COMPUTING

March 25, 1993

The Subcommittee meets today to continue its examination of technology policy and the President's program to encourage the rapid development of an advanced, high-speed, broadband information infrastructure for the United States.

On Tuesday, I provided a brief sketch of a number of the themes in the President's program that we are examining. I will not repeat them this morning but my statement is available to anyone who could not be here on Tuesday.

Today we hope to elicit more testimony on the implementation to date of the High Performance Computing and Communications Program established by the 1991 High Performance Computing Act.

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We will be hearing from Mr. Salim Bhatia who is President of Broadband Technologies, Inc. in Research Triangle Park, North Carolina. Broadband Technologies is a small business telecommunications equipment vendor, and Mr. Bhatia and his firm are engaged in testbed activities with our regional Bell operating companies. Mr. Bhatia is a constituent of mine and I want to extend a special welcome to him.

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We will receive testimony from Dr. Stephen Gage, President of the Cleveland Advanced Manufacturing Program.

This Subcommittee has proposed legislation, H.R. 820, which contains programs intended to revitalize the manufacturing base of our nation. The manufacturing model for the next century is "agile manufacturing", which involves short design cycles, production in small lots, and rapid reconfiguration of product lines.

An agile manufacturing factory must be able to access a modern information network to support all aspects of the design-to-production cycle. A broadband high-speed network will also play an important role on the manufacturing floor. For example, an advanced network will enable computer-controlled tools to fabricate parts directly from design databases. I am sure we will hear more about this from Dr. Gage.

We will also receive testimony from Mr. T. J. Rodgers, President and CEO of Cypress Semiconductor of San Jose, CA.

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I want to thank all the witnesses for being with us today. I also want to remind the witnesses that they should try to limit their oral statements to five minutes so we will have ample time for discussion.

I would now like to recognize the Ranking Minority Member, Mr. Lewis from Florida, for any opening statement he may wish to make, and then recognize Mr. Hoke to introduce Dr. Gage.

Mr. VALENTINE. We'll be joined by other members. Just a word of explanation, you know we have had a series of votes and there's a lot—so the fact there's only one person here shouldn't be taken as any bit of discouragement.

I think that, because we have these very serious time constraints, I will ask other members—the other panel if you can come up. If we can find seats for everybody, we'll just deal with this as one big panel. We'll recognize Dr. Lindberg first, but we'll pause a second for the others to come up and take their places.

The Chair is happy to recognize the distinguished gentleman from California, if he has a brief opening statement, Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you, Mr. Chairman. I am looking forward to the witnesses and the hearing. Thank you.

Mr. VALENTINE. Dr. Lindberg, welcome.

STATEMENT OF DONALD A. B. LINDBERG, M.D., DIRECTOR, NATIONAL COORDINATION OFFICE FOR HIGH PERFORMANCE COMPUTING AND COMMUNICATIONS, AND DIRECTOR, NATIONAL LIBRARY OF MEDICINE; ACCOMPANIED BY SALIM A. L. BHATIA, PRESIDENT, BROADBAND TECHNOLOGIES, INC., RESEARCH TRIANGLE PARK, NORTH CAROLINA; SIDNEY KARIN, DIRECTOR, SAN DIEGO SUPERCOMPUTER CENTER, SAN DIEGO, CALIFORNIA; STEPHEN GAGE, PRESIDENT, CLEVELAND ADVANCED MANUFACTURING PROGRAM, CLEVELAND, OHIO; T. J. RODGERS, PRESIDENT AND CEO, CYPRESS SEMICONDUCTOR, SAN JOSE, CALIFORNIA; AND JEFFREY KALB, PRESIDENT AND CEO, MASPAR COMPUTER CORPORATION, SUNNYVALE, CALIFORNIA, REPRESENTING THE AMERICAN ELECTRONICS ASSOCIATION

Dr. LINDBERG. Thank you, Mr. Chairman.

Mr. VALENTINE. We would—I would ask you, please, sir, if you could summarize to about five minutes or so, and we'll appreciate it. And your prepared statement, of course, will appear in the record as presented to us.

Dr. LINDBERG. Thank you very much. I'll attempt to do that.

The High Performance Computer and Communications Program is an FCCSET initiative. It is developing computing, communications, and software technology that the U.S. will need to meet its information and telecommunications needs. It will lay the foundation for an Advanced National Information Infrastructure. The HPCC Program will play a key role in the administration's effort to accelerate the development of a National Information Infrastructure. This effort is outlined in the administration's technical policy paper, "Technology for America's Growth," released by the President and Vice President in California on February 22.

The administration proposes to invest more than $2 billion in new funding for Fiscal Year 1994 to 1997 in order to demonstrate and develop advanced computing and networking technology. The HPCC Program will receive, would receive most of that funding. The rest, over $500 million, would be spent by the National Telecommunications and Information Administration of the Department of Commerce to enable schools, libraries, hospitals, and other

nonprofit institutions to connect to the Internet and commercial networks.

The HPCC program and the NTIA program are both intended to spur private sector investment in developing a ubiquitous, high-speed telecommunications network that will eventually reach every home, business, and school in the country. The HPCC program is a result of several years of effort on the part of senior government, industry, and academic scientists and managers. I'll only touch upon the highlights of some of the past.

In 1986, then-Senator Gore and members of the Science Committee proposed the Supercomputing Network Study Act. This was incorporated in the National Science Foundation reauthorization bill and, ultimately, the Office of Science and Technology Policy produced the report, "A Research and Development Strategy for High Performance Computing." This provided the justification and reasoning for the High Performance Computing Act, which then-Senator Gore introduced the following year. Thanks to the strong support of Representatives George Brown, Tim Valentine, Rick Boucher, and other members of this committee, for which I'm certain he's grateful, that bill passed the Congress, and was signed into law in December 1991. That act articulated a national information vision for the future.

Now, the purposes for which this computing constellation is being put range from scientific Grand Challenges, such as investigating world climate modeling and environmental pollution remediation, or organizing the data from the human genome project, down to some applications that are easily understood and will affect all Americans directly—for example, improvements in health care, education and life-long learning, digital libraries, and manufacturing advances.

The program currently is constituted of 10 federal agencies, and they are organized into four major programs. The budgeting material is also included in my written testimony, and may be better accessed through that; although I'd be happy to answer any questions that you wish to raise.

I should give you a comment on progress. How do we stand? Basically, the program is going extremely well, as far as I can see. The research projects are in place. These include supercomputer centers and organized programs. There are interagency research programs that seem to me to touch upon fundamentally very important areas and also have good progress.

The NREN, especially the National Research and Education Network, which is specified in the congressional resolution, is ahead of schedule in its development, both in terms of the speed of the network, the number of connections, the number of countries, the type of data, the quality of the research. All of this is ahead of schedule. I might say that that is—that particular part is managed by National Science Foundation extremely ably.

Mr. Chairman, this is a very, very superficial summary to fit within the time constraints. I would be happy to answer further questions in any area you, or the other members, of the committee might choose.

In closing, I want to thank the subcommittee for this opportunity to discuss the HPCC. I find this the most exciting and important

scientific program I have ever encountered and certainly the most important one I've ever encountered in nine years in government. To me, it is something we should all be proud of. It provides a clear example of what is possible when government, industry, and the academics work together toward a common goal.

I, again, would be happy to take questions, if you wish.

[The prepared statement of Dr. Lindberg follows:]

Testimony on High Performance Computing and Communications

Before the
House Committee On Science, Space, and Technology
Subcommittee on Technology, Environment, and Aviation
by
Donald A. B. Lindberg, M.D.
Director, National Coordination Office for
High Performance Computing and Communications,
and
Director, National Library of Medicine

March 25, 1993

Mr. Chairman and Members of the Subcommittee:

I am pleased to speak to you about the High Performance Computing and Communications Program, and the development of the NREN (National Research and Education Network). I speak in my capacity as the recently appointed director of the National Coordination Office that oversees the multi-agency Federal High Performance Computing and Communications Program. In that role, I am a Special Assistant to the Director of the Office of Science and Technology Policy (OSTP). I also serve as the Director of the National Library of Medicine, and as the National Institutes of Health (NIH) representative to the Physical, Mathematical, and Engineering Sciences Committee of the Federal Coordinating Council for Science, Engineerings, and Technology (FCCSET).

A FCCSET Initiative, the HPCC Program is developing computing, communications, and software technology the U.S. will need to meet its information and telecommunications needs. It will lay the foundation for an advanced national information infrastructure (NII) consisting of high-speed communication links, high performance computers, and powerful, but user-friendly software that will give every American access to an unprecedented amount of information, as well as the tools needed to effectively process and use it. This infrastructure

will spur gains in U.S. productivity and industrial competitiveness, improve our national security, and improve the health and education of our citizens. The HPCC Program is the result of several years of effort on the part of senior government, industry, and academic scientists and managers to design a research agenda to extend U.S. leadership in high performance computing and networking technologies.

The HPCC Program will play a key role in the Administration's effort to accelerate the development of the national information infrastructure (NII) that this Nation will need for the 21st Century. This effort is outlined in the Administration's technology policy paper, "Technology for America's Growth, A New Direction to Build Economic Strength," released by the President and Vice President in Silicon Valley on February 22.

The Administration intends to provide both new policies and new funding to accelerate the private sector's development and deployment of an advanced NII. An Information Infrastructure task force is being formed, to be run by OSTP and the National Economic Council, which will define the Administration's vision for the NII, formulate forward-looking telecommunications and information policies needed to fulfill that vision, and work with industry, state and local governments, public-interest groups, and Congress to implement those policies.

In addition, the Administration proposes to invest more than $2 billion in new funding for FY94-97 in order to develop and demonstrate advanced computing and networking technology. The HPCC Program will receive most of that funding. The rest, over $500 million, will be spent by the National Telecommunications and Information Administration of

the Department of Commerce to enable schools, libraries, hospitals, and other non-profit institutions to connect to the Internet and commercial networks. The HPCC Program and the NTIA program are intended to spur private sector investment in developing a ubiquitous, high-speed telecommunications network that reaches every home, business, and school in the country.

A decade ago, in the spring of 1983, the Office of Science and Technology Policy (OSTP) formed three interagency panels under the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) to examine critical emerging issues in the computing field. The first report of the FCCSET Computer Research Coordination Panel was released two years later, in June of 1985.

The panel recognized that "sustained and growing support for basic research is necessary for advancement in the Very High-Performance computing field," and issued recommendations "intended to ensure that the United States continues to be the prime source of Very High-Performance Computing technology in the decades ahead." Although noting that high performance computing was investigated by a number of Federally sponsored studies, reports, and workshops since the early 1960s, the panel found that "interest in these issues declined in the mid 1970s as Government funding levels fell off." The renewed interest in this area within the past 10 years arose largely as a result of "the perceived threat of foreign competition, the emergence of innovative architectural concepts in parallel and multiprocessor machines for scientific and symbolic computation, and the identification of a broad spectrum of mission-specific applications that will require radical improvements in the speed and performance of computing systems." This renewed interest led to activities such

as the Advanced Research Projects Agency's (ARPA) Strategic Computing Program, the National Science Foundation's (NSF) Advanced Scientific Computing Program, the Department of Energy's (DOE) Energy Science Supercomputing Program, and the Department of Defense's (DOD) Supercomputer Research Center. In FY 1985, total Federal investment in high performance computing research approached $101 million.

In 1986, then Senator Gore and members of the Science Committee proposed the Supercomputing Network Study Act, which passed later that year as part of the National Science Foundation Reauthorization Act. This legislation required the White House Office of Science and Technology Policy to report to Congress on how the Federal government could promote supercomputing and high-speed computer networking. That report, "A Research and Development Strategy for High-Performance Computing," was released in November 1987 and outlined an ambitious five-year, multi-billion dollar plan to expand Federal high performance computing research and development programs. It provided the justification for the High-Performance Computing Act, which then Senator Gore introduced the following year. Thanks to the strong support of Representatives George Brown, Tim Valentine, Rick Boucher, and other members of this Committee, that bill passed the Congress and was signed into law in December 1991. The act articulated a national information vision for the future.

The Act (Public Law 102-194) expressed the finding of the Congress that the United States, if it is to remain among the world leaders in high performance computing and communications networking, must engage in a dedicated, government-supported effort. To do this, the Act established a National High Performance Computing Program that will set goals and priorities, coordinate the programs of Federal agencies, establish a high-capacity and

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high-speed National Research and Education Network (NREN), and support research, development, and training in all facets of high performance computing and networking.

The Act notes the existence of "Grand Challenges" -- fundamental problems in science and engineering, with broad economic and scientific impact, whose solution will require the application of such high performance computing resources. There are many such challenges. Some are in the area of biomedical research: designing drugs to treat cancer and AIDS, building a complete anatomical image library of the human body, and handling the immense amount of data resulting from research into the human genome. Other challenges involve the environment: designing engines to optimize combustion and minimize pollution, modeling ocean phenomena that affect climate, studying the complex mechanisms associated with ozone depletion, and modeling the formation and transport of air pollutants. Some concern primarily industry: examples are magnetic recording media that pack more information, designing high-speed civilian aircraft, and computer-designed catalytic processes used in manufacturing. And still others will affect the public directly: better patient care through the networking of diagnostic and treatment information, lifelong learning through remote databases and interactive video, meteorological applications such as tracking hurricanes, improving services to the disabled and housebound, and allowing citizen access to public and private databases and other unique information resources.

Many of these Grand Challenges will be dependent on the development of the high-speed and high-capacity National Research and Education Network (NREN). The purpose of this component of the HPCC Program is to establish a communications infrastructure that will significantly enhance researchers' access to distributed computing capabilities at research and

educational institutions nationwide. The NREN program will advance the state of the art of networking technology and services, broaden access within the research and education community to state-of-the-art high performance computing facilities, and act as catalyst for the development of a truly general purpose high speed communications infrastructure for the entire nation.

When its vision is fully implemented, scientists and others will be able to transmit information at the rate of a billion bits a second (the "gigabit" network). This will revolutionize the ability of scientists to carry out collaborative research with colleagues around the country. In addition, it will serve as an invaluable test-bed for new communications technologies. In order to establish such an infrastructure, major new networking technologies have to be developed and deployed, and new products and services from common carriers and other communications service providers must be made available.

Two years ago the number of users of the present data network, Internet, was estimated at about 100,000. Today there are more than one million computers on the Internet and almost 10,000 networks, capable in many instances of sending and receiving data streams of 45 megabits per second. About 1,000 universities and colleges are attached to and using Internet, and about the same number of high schools. Today, there is also an emphasis on connecting community colleges and hospitals, and on further experiments to determine the best way to attach local school systems.

Interagency coordination and planning

Through coordinated planning, research, and development, the nine agencies in the

HPCC Program are creating a single integrated nationwide infrastructure for high performance computing and communications and for information technology. That infrastructure enables them to address agency missions such as the computational Grand Challenges and to carry out the systems integration and applications development for the proposed National Information Infrastructure. This coordination allows them to leverage their efforts in areas of common need and mission overlap. No individual agency has either the mission or the expertise to develop all components of the infrastructure, but each agency plays a necessary and unique role.

One example of interagency coordination under the HPCC Program is the development of new computing and communications resources for climate research. Five Federal agencies sponsor climate modeling research under the HPCC Program: ARPA, DOE, NASA, NSF, and the National Oceanic and Atmospheric Administration (NOAA).

The Earth's atmosphere-ocean system and the physical laws that control its behavior are very complex and contain many subtle details. This coupled atmosphere-ocean model is the primary tool by which climate scientists simulate the behavior of the Earth's climate system. However, this system is only crudely represented by the most comprehensive of present-day climate models. Climate model improvements will require a hundred to thousand fold increase in computing, communications, and data-management resources before the goals can be met.

Researchers at several sites in the participating agencies are redesigning atmosphere and ocean models for execution on new scalable parallel computer architecture systems.

Scientists are also investigating distributed computing strategies that will use a gigabit per second data transfer between distant supercomputers.

Although the HPCC Program has been a model for inter-agency coordination in this and other cross-cutting areas, a focal point for coordination activities was needed. In September 1992, the National Coordination Office (NCO) for High Performance Computing and Communications was established. The NCO coordinates HPCC programs across Federal agencies, acts as a liaison to industry, universities, and Congress; and provides information and communications about HPCC.

HPCC structure and organization includes a process for strategic planning. The program prepares an annual implementation plan and a budget document that detail objectives, strategies, and milestones for high performance computing and communications efforts, for use of the Committee on Physical, Mathematical, and Engineering Sciences of the Federal Coordination Council for Science, Engineering, and Technology (FCCSET) , and the Office of Management and Budget.

Program leadership is provided by the Office of Science and Technology Policy, through the FCCSET Committee on Physical, Mathematical, and Engineering Sciences (PMES). As director of the National Coordination Office for HPCC, I serve as chairman of the PMES High Performance Computing, Communications and Information Technology (HPCCIT) Subcommittee. HPCCIT meets monthly to coordinate agency HPCC programs through information exchanges, the common development of interagency programs, and the review of individual agency plans and budgets.

Meetings of the 13-member group are attended regularly by several dozen additional representatives from government agencies and the Administration who are interested or involved in high performance computing and communications.

An executive committee comprised of a subset of HPCCIT members meets at least once a month, and more often as needed in order to provide a timely response to issues that may arise between regularly scheduled meetings of the HPCCIT Subcommittee.

Four HPCCIT working groups meet regularly to coordinate each of the four components of the HPCC initiative. The Computer Research and Development Group, led by the Advanced Research Projects Agency (ARPA), is concerned with basic research progress, technology trends, and alternative approaches to address technological limits in information technology. The Education for High Performance Computing group, led by NIH, coordinates HPCC education and training activities and provides liaison with other education-related efforts under FCCSET.

The Science and Engineering Computing Group, led by NASA, coordinates activities related to Grand Challenge applications, software tools needed for applications development, and software development at high performance computing centers. This applications group has sponsored workshops on systems software development for high performance computing; holds annual Grand Challenges workshops to coordinate these Federally funded scientific teams; and hosts bi-annual meetings in which industry representatives describe their future offerings and views concerning key issues that should be addressed by the Government.

In addition to coordinating applications across agencies, the group works with other FCCSET Initiatives and Programs, particularly that for Global Change Research. It acts as a liaison between the two initiatives and more than six Federal agencies in coordinating predictive modeling efforts for global change. The group also collaborates with other Federal agencies to establish benchmarks for evaluating new machines and shares machines and testbeds for evaluation.

The Networking Infrastructure and Digital Communications Group, led by the National Science Foundation, coordinates network integration activities and works closely with the Federal Networking Council (FNC). The FNC consists of representatives from many Federal agencies that are dependent upon advanced computer networks such as NREN. It coordinates the efforts of government HPCC participants and other NREN constituents; and provides liaison to others interested in the Federal program. A Federal Networking Advisory Committee (FNAC) including representatives of universities and industry supports the FNC.

Additional task groups are being established to plan interagency coordination and implementation of new applications to broaden the high performance computing and communications infrastructure to include medical facilities, libraries, schools, other educational institutions, and ultimately homes and businesses. Development of advanced applications software will improve health care, manufacturing, energy use, and the environment, and provide for improved education and life-long learning. Development of an information infrastructure, including digital libraries, will support these advanced applications.

Private Sector Coordination

Both individually and as members of the HPCC Program, participating agencies collaborate with industrial partners, fund research and development in the private sector, and work with representatives in planning the HPCC Program. Frequent conferences and workshops are held with the private sector and academia, including the presentations by major vendors that I've described.. Private sector consortia and academic forums regularly provide analyses and opinion about the Program. Organizations involved include the National Academy of Sciences; EDUCOM and the Computer Research Association, representing academic institutions; associations such as the Computer Systems Policy Project (CSPP); professional societies such as the Institute of Electrical and Electronics Engineers, the American Institute for Medical and Biological Engineers, and others.

Development of the NREN

The Interagency Interim NREN (IINREN) is a hierarchy of networks, ranging from high-speed cross-country networks, to regional and mid-level networks, to state and campus network systems. The major federal components of the IINREN are the national research agency networks: NSF's NSFnet, DOE's Energy Sciences Network (ESnet), and NASA's NASA Science Internet (NSI). These agencies' networks constitute national network backbones that will collaborate in attaining NREN's gigabit speeds.

The NSFnet has experienced tremendous growth in the number of connections it supports, and in the amount of traffic that it carries. More than 800 of the approximately 4,000 two-year and four-year colleges and universities in the nation are interconnected, including all the schools in the top two categories of the Carnegie classification; and an

estimated 1,000 high schools are also connected. The exact number is difficult to determine since regional networks have leveraged NSF funds to connect such institutions without NSF's direct involvement, and some state initiatives such as one in Texas proceed with little or no Federal involvement.

Message traffic on the NSFnet backbone has doubled over the past year, and has increased a hundred-fold since 1988. NSF's engineering improvements to handle this traffic increase have enabled it to support higher throughput and have advanced the state of network technology and operations.

A group of five gigabit network research testbeds established last year and jointly sponsored by NSF and ARPA are in various stages of completion. AURORA, BLANCA, CASA, NECTAR and VISTANet should all be operational by the end of this fiscal year, providing the fabric for some initial experiments. The research at these testbeds focuses on network technology and network applications with special attention paid to alternative network architectures, implementations, and applications.

Each testbed explores one or more aspects of high performance distributed computing and networking: The AURORA testbed on the east coast has planned investigations into multimedia systems and distributed shared memory; BLANCA, a coast-to-coast testbed, will provide implementation fabric for atmospheric modeling and visualization and an experimental multimedia digital library; CASA, with end-points in California and New Mexico seeks to further extend the parallel computing model using the network to carry out large scale scientific and engineering computations; NECTAR, in Pennsylvania, concentrates

on gigabit rate switch design and implementation; and the last joint testbed, VISTANet in North Carolina, will explore remote medical imagery and diagnosis. As a whole, the testbeds seek to create and investigate a balanced high performance computing and communications environment.

The testbed teams consist of government agencies (NSF, ARPA, DOE, NASA,) supercomputer centers, state centers, academic institutions, and also a number of local and long distance telephone companies that are participating both as service providers and experimental team members.

The National Science Foundation (NSF) is the lead agency for the NREN program. In addition to supporting the development and deployment of gigabit/second technologies, NSF coordinates IINREN networking activities and provides enhanced services on the IINREN. NSF also supports the primary source of information on access to and use of the network, and assists regional research and education networks to upgrade and enhance their own services. A number of outreach efforts exist to increase access to the NREN. NASA supports researchers at its gigabit testbed facilities and at universities and has pilot programs with elementary and secondary schools.

My own institution, the National Library of Medicine, a component of the National Institutes of Health, has been a leader in outreach efforts to help make health professionals more effective by educating them about modern information services, and by lowering the barriers to access biomedical information. As an example, the NLM makes available a personal computer program called Grateful Med, which allows a health professional or

researcher to formulate a database search online in the office or home, by simply filling in a form displayed on the PC screen. Grateful Med then automatically connects to the NLM computers and transmits the search results to the user's own computer. Over 50,000 copies of this program have been distributed, and the majority of searches of NLM databases now are conducted via this "user-friendly" software. Grateful Med provides access not only to MEDLINE, the NLM's premier biomedical literature database, but also to a growing number of specialized information collections on topics such as AIDS, cancer treatment, bioethics, and toxicology databanks. The system pre-dates NREN, but has become much more effective now that many institutions can use these information access systems at the greater resolution and higher speeds that NREN permits. NLM joins NSF in a Medical Connections grant program to provide assistance to medical centers to become connected to the NREN.

Your Subcommittee has expressed interest in issues such as network security and how to protect the copyright of information distributed over the NREN. Network security and copyright are issues that will require participation by more than just the Federal government. These issues are very complex -- from policy, legal, and technological perspectives. Private, educational, and industrial sector input is needed to help resolve these issues.

The NREN has been exploring ways of providing security and privacy. Secure data or functions that relate directly to an agency's mission, such as NASA launches, are not put on NREN, but are protected by a "fire wall" from public access areas of the NREN. As the NREN moves forward, however, security will become an increasingly important issue. The National Security Agency and the National Institute of Standards and Technology (NIST), both participating agencies in the HPCC Program, are actively working in this area. A

recent report by NIST discussed the technical mechanisms possibly appropriate to protect copyright of material distributed over the network.

Most of the protection issues concerning the NREN are not new, but exist for communications systems that are accessible to the public in general, like the telephone network. It is important that protection policies and mechanisms developed for the NREN be consistent with those that already exist for industry and the public more generally.

We HPCC agencies are seriously interested in and concerned about problems of privacy, copyright, and security on NREN -- even if it turns out that NREN does not create any unique needs. We do sponsor, participate in, and plan to benefit from conferences, hearings, and studies of these complex matters by scholars in the university, public and industrial arenas.

Federal and privately-sponsored workshops on copyright protection and security and privacy are seeking to build a consensus in this complex area. For example, a two-day workshop to be held in April at Harvard University will address "technological strategies for protecting intellectual property in the networked multimedia environment." In May, Harvard will host another two-day workshop on "Public Access to the Internet," in which participants will discuss cost and pricing models, disparities and inequities, as well as privacy and First Amendment issues.

I want to thank the Subcommittee for this opportunity to discuss the High Performance Computing and Communications Program. This is one of the most exciting initiatives that I have even been involved in and one that I believe we all should be proud of. It provides a

clear example of what is possible if government, industry, and academic work together toward a common goal.

I shall be happy to answer any questions.

Biographical Sketch

Donald Allan Bror Lindberg, M.D.

Donald A. B. Lindberg, M.D., was named the first Director of the National Coordination Office for High Performance Computing and Communications in August 1992. He has served as Director of the National Library of Medicine since 1984. In addition to an illustrious medical career in pathology, Dr. Lindberg has made notable contributions to information and computer activities in medical diagnosis, artificial intelligence, and educational programs. Before his appointment as Director, Dr. Lindberg was Professor and Chairman, Director of Information Science; University of Missouri School of Library and Information Science, Professor of Pathology, University of Missouri School of Medicine, 1969-1984; and Director, Information Science Group, University of Missouri School of Medicine, 1971-1984.

Dr. Lindberg was elected the first President of the American Medical Informatics Association (AMIA), 1988-1991 and in 1992 began serving as a member of the AMIA Board of Directors. He has also been called upon to serve on many boards including the Computer Science and Engineering Board of the National Academy of Sciences, the Symposium on Computer Applications in Medical Care (SCAMC), the American Association for Medical Systems and Informatics (AAMSI), the Organizing Committee for MEDINFO 86, the National Board of Medical Examiners, the Institute of Medicine Advisory Council of the National Academy of Sciences and the Advisory Council of the International Hospice Institute.

Dr. Lindberg is the author of three books: The Computer and Medical Care; Computers in Life Science Research; and The Growth of Medical Information Systems in the United States, several book chapters, and more than 150 articles and reports. He has served as editor and editorial board member of nine publications, including the Journal of the American Medical Association.

Dr. Lindberg graduated ***Magna cum Laude*** from Amherst College and received his M.D. degree from the College of Physicians and Surgeons, Columbia University. Among the honors he has accrued are Phi Beta Kappa; Simpson Fellow of Amherst College; Markle Scholar in Academic Medicine; Surgeon General's Medallion; recipient of the First AMA Nathan Davis Award for outstanding Member of the Executive Branch in Career Public Service, the Walter C. Alvarez Memorial Award, American Medical Writers Association; the Presidential Senior Executive Rank Award; Founding Fellow, American Institute of Medical and Biological Engineering; the Outstanding Service Medal, Uniformed Services University of the Health Sciences; and honorary doctorates from Amherst College, the State University of New York at Syracuse and the University of Missouri-Columbia.

Mr. VALENTINE. Thank you, sir.

Mr. Bhatia?

Mr. BHATIA. Mr. Chairman, thank you for the opportunity to testify before this subcommittee. My name is Salim Bhatia and I am the president of BroadBand Technologies, Inc. We are a young American company, a young American high-technology company. We are located in Research Triangle Park, North Carolina and are proud to be constituents of Chairman Valentine.

I would like to share our story because I believe that the history of BroadBand Technologies represents a prime example of the bright horizons, but daunting obstacles that confront American technologists, specifically, American technologists who seek to contribute to our President's and this subcommittee's vision of an information superhighway available to all Americans. I will, with this background then, draw three public policy conclusions gained from our experience.

We were born as a company in 1988. We were essentially an employee buyout of the BroadBand Associated Electronic Research, that was at that time underway at SIECOR. At that time, there was substantial question whether the United States would commit to wide deployment of broadband networks. The policy climate was decidedly uncertain and not conducive to short-term investor confidence. We essentially created BroadBand Technologies in an act of faith, faith in a vision, a vision that the Clinton administration and this subcommittee are now promoting, a vision that all Americans could be linked to the health care, educational, and entertainment treasure troves of our information age via interactive broadband networks—faith in American policymakers here in Congress, and at the Federal Communications Commission, that they would clear the outmoded regulatory roadblocks to deployment of this network, and faith in ourselves, in our ability to develop our good ideas into affordable products.

We supply the technology—the electronics, hardware, and software—that switches voice, data, and video over fiber optic lines to the curb. When we began, the conventional wisdom declared that such technology would be prohibitively expensive; it would be only affordable to large corporations and institutions. In addition, even most industry pundits expected that this technology would not become available until the second half of the 1990s. We at BroadBand Technologies bet that we could make the technology affordable and available much sooner, and we did. In fact, we introduced the technology in trials in July of 1991, only three short years after the company's inception.

And today we announced another technological breakthrough that should effectively moot any further arguments against the deployment of the ubiquitous interactive broadband network. This breakthrough also counters testimony by Dr. Dick Green of Cable Labs advanced here on Tuesday that significantly overstated the cost of telephone company offering of broadbase services. We are announcing a technological breakthrough that will enable telecommunications companies to deliver more than 1,500 interactive video channels on demand, at a cost to them of less than $500 per customer. This is a 20-fold improvement in capability, dramatically

increasing the capacity of our delivery platform while lowering the cost for a subscriber.

In the same way that telecom companies give access to almost anyone in the world just by picking up a telephone, our new technology will enable Americans to access a nearly unlimited number of video sources simply by turning on the TV. However, without regulatory and legislative reform, this cost-competitive infrastructure cannot be fully realized. We at BroadBand Technologies not only have to bet on our ability to achieve technological breakthroughs and satisfy consumers, but we must also bet on an uncertain legal, regulatory, and investment environment—an environment which provides neither focus nor incentive, for the modernization of the nation's information infrastructure.

Regulatory and legal uncertainty is perhaps our largest hurdle to overcome. Last year, the FCC took substantial steps toward alleviating these regulatory constraints in its video dialtone decision. In this decision, it defined a regulatory framework for telephone companies to offer video on a common carrier basis; but in its video dialtone decision, the FCC left unresolved many important policy issues. If the President's plan is, indeed, to ensure that federal regulatory policy encourages investment in innovation and technology development, a first step would be to complete this proceeding and grant the Section 214 application pending for service in the State of New Jersey.

While very important to our company, completing the video dialtone proceeding at the FCC is still but a limited step in the scheme of things. There is, in fact, a greater legal hurdle to scale. Section 613(b) of the Communications Act prohibits telephone companies from providing video programming within their local service areas. The cross- ownership restriction tends to maintain the artificial boundaries between the types of businesses that computer and communications technologies are constantly blurring. I urge you to complete action in this Congress on bills that would remove the ban on telephone company provision of video programming.

The second way government can support its goals to create a national information highway is to establish generally an enabling environment for technology development and commercialization. Stable investment in technology requires a stable environment for business planning. Government can provide stability for firms such as ours by making permanent the investment tax credit. Government can also prescribe more rational depreciation schedules for telephone companies—

Mr. VALENTINE. Excuse me. We're going to have to suspend. All these bells and stuff—we've got a couple of votes. And if you will just take five or 10 minutes off to talk to each other, we'll be back. In the old days you'd say, "Smoke if you've got them," but I can't say that anymore.

[Laughter.]

[Recess.]

Mr. VALENTINE. Mr. Bhatia?

Mr. BHATIA. Knowing that we're short of time, I will go just to the last one more point that I would like to leave for this committee. It's time to act. The technology exists. It is economic, but legal gridlock and uncertainty are slowing deployment and the develop-

ment of mass market applications. Our nation's industrial competitors are actively promoting a vision of interactive broadband networks.

At BroadBand Technologies, where we are among the world leaders in broadband technology innovation, we are quite concerned. We have bet our careers on a national vision of affordable, interactive broadband networks. In the five years since we began, our success in the laboratory and in field trials with many customers has boosted our faith in ourselves and our technology, but the legal and regulatory roadblocks must be removed wisely and quickly. This committee has the opportunity to ensure that our corporate lead and America's chance to lead in broadband network innovation is not undermined.

Thank you very much for your attention. I am happy to answer any questions later.

[The prepared statement of Mr. Bhatia follows:]

Statement of Salim A.L. Bhatia
President

Hearing on Information Infrastructure,
Information Superhighways, and
High Performance Computing

Before the Subcommittee on Technology,
Environment and Aviation

of the

House Science, Space and Technology Committee

March 25, 1993

Mr. Chairman:

Thank you for the opportunity to testify before this Subcommittee. My name is Salim Bhatia, and I am the President of BroadBand Technologies, Inc. We are an American start-up high technology company, located in Research Triangle Park, North Carolina. We were founded in 1988 by a group of present BroadBand Technologies officers and employees, including myself.

Our mission at BroadBand Technologies is to provide telecommunications network operators with the systems required to transform the local exchange carrier network to interactive switched digital broadband technology. The BroadBand Technologies' Fiber Loop Access (FLX) system is currently installed in trials and first office applications at several major telecommunications companies.

BroadBand Technologies is honored to be invited to testify at this hearing, and to be in the company of such distinguished witnesses, including those representing multi-billion

dollar companies. BroadBand Technologies is at a much earlier stage of our life cycle. While our technology is very widely respected, and considered to be highly promising, after five years of operation we are still in a "start-up" mode, and have yet to turn a profit.

I would like to share our story because I believe that the history of BroadBand Technologies represents a prime example of the bright horizons -- but daunting obstacles -- that confront American technologists who seek to contribute to this Subcommittee's vision of an "information superhighway" available to all Americans. I then will draw three public policy conclusions gained from our experience.

We were born as a company in 1988 by what was essentially an employee buy-out of the broadband-associated electronics research then underway at SIECOR. At that time, there was substantial question whether the United States would commit to wide deployment of broadband networks. The policy climate, including the Cable Act of 1984's ban on telephone company entry into video services, was decidedly uncertain and not conducive to short term investor confidence. SIECOR chose not to continue this interactive broadband development work, admittedly admirable in laboratory settings, given the protracted uncertainty of whether it would have a place in America's network of tomorrow.

We essentially created BroadBand Technologies in an act of faith.

Faith in a vision, that the Clinton Administration and this Subcommittee are now promoting, that all Americans could be linked to the health care, educational and entertainment treasure troves of our Information Age via interactive broadband networks.

Faith in American policymakers, here in Congress and at the Federal Communications Commission, that they would clear the outmoded regulatory roadblocks to deployment of this network.

And, faith in ourselves and our ability to develop our good ideas into affordable products.

We founded BroadBand Technologies with the vision of building a world class company that would play a vital role in the transformation of the nation's copper-based local telecommunications network into an advanced, interactive superhighway that would bring the power of switched digital optical fiber to all Americans.

We supply the electronics hardware and software that switches and transmits voice, data and video technology over fiber optics lines to the curb. Conventional wisdom when we began declared that such technology would be expensive and, therefore, only affordable to large corporations and institutions. In addition, even most industry pundits expected that the technology would not become available until the second half of the 1990's. We bet, however, that we could make the technology both affordable and available much sooner. And we did. In fact, we introduced the technology in trials in July, 1991, only three short years after the company's inception.

Where people believed it would take a centralized, complex, high-speed computerized switch to provide a ubiquitous interactive capability, costing hundreds of dollars per subscriber, the BroadBand Technologies team invented a way to distribute the switching and

to put this capability on an eight dollar chip that serves 8 to 24 subscribers. We also devised a way to carry out this function on an electronic module the size of two index cards, as opposed to the initial estimate of a refrigerator-sized cargo box.

BroadBand Technologies will very shortly announce another technological breakthrough that should effectively counter the last argument against ubiquitous broadband network deployment. We will announce a technology and cost breakthrough that will enable telecommunications companies to deliver more than 1,500 interactive video channels on demand at a cost to them of less than $500 per customer. This is a twenty-fold improvement in capability, dramatically increasing the capacity of our delivery platform to 1,500 sources, while lowering the cost per subscriber. In making available this technology/cost breakthrough in video delivery, BroadBand Technologies will combine its FLX switched video system with the Motion Picture Experts Group's (MPEG) emerging digital compression standard and Asynchronous Transfer Mode (ATM) switching and multiplexing technology. In the same way that telecommunications companies give customers access to almost anyone in the world just by picking up a telephone, our new technology will enable consumers to access a nearly unlimited number of video services simply by turning on the television.

Currently, only the roughly 25 to 35 percent of American homes equipped with computers have a chance to access the wealth of information available over telecommunications networks. Far fewer households are equipped with modems that permit interactive use of the network. Using our technology, every television in America can be inexpensively converted into an interactive broadband terminal.

This type of infrastructure development will greatly improve American productivity, quality of life and competitive advantage, while simultaneously providing telecommunications providers with a return on their investment.

However, without regulatory and legislative reform, this cost competitive infrastructure cannot be fully realized. Significant progress has been made with the lifting of the AT&T Consent Decree's information services ban and with the Federal Communications Commission's Video Dialtone Decision, but these changes have come slowly, accompanied by too much uncertainty.

We at BroadBand Technologies not only have to bet on our ability to achieve technological breakthroughs and satisfy consumers, but we must also bet on an uncertain legal, regulatory and investment environment -- an environment which provides neither focus nor incentive for the modernization of the nation's information infrastructure.

We are pleased with our own progress at BroadBand Technologies and especially by our technological breakthrough announced today. But, five years after we stepped out on the interactive broadband technology limb, and in spite of making several excellent technology predictions and breakthroughs, we continue to contend with this uncertain regulatory and investment environment in trying to build a market for our innovations.

The environment could prevent both BroadBand Technologies and consumers from reaping the benefits of our investment in precisely the technology that this Subcommittee wishes to foster.

We at BroadBand Technologies are encouraged by President Clinton and Vice President Gore's intention to promote investment in the information infrastructure, and more importantly by some of the specific policies they promote to build a "world-class business environment" for innovation and investment. In the same way that roads changed America in dramatic ways -- so too can our technology and other innovative telecommunications-related services unleash a tremendous creative and productive energy, accessible to all Americans. This will promote economic growth and strength throughout our nation. But government must first set the stage to ensure that the private sector invests.

This leads me to the second part of my testimony. What can you as policymakers do to make our vision of a national, broadband, interactive network come true? Three steps are needed: one, to end legal and regulatory barriers to interactive broadband deployment; two, to create a more enabling environment for technology development and commercialization generally; and finally, to promote applications that make this network much more accessible to all Americans.

Regulatory uncertainty is perhaps our largest hurdle to overcome. It engenders reluctance on the part of our primary customers. Many are just not willing to gamble that government regulations will allow for telephone company participation on an equal basis in video delivery. The primary legal and regulatory constraints to which I am referring are those that hinder telephone operating companies from offering video programming, since video will likely be the primary engine of broadband deployment.

Originally, the FCC adopted rules to prevent local telephone companies from preemptively establishing a monopoly position in the provision of cable or video services. This allowed the then infant cable industry to grow to where it is now a $20 billion industry with facilities passing more than 90 percent of the homes in this country. In 1984, Congress codified these crossownership restrictions as part of its law deregulating cable.

Last year the FCC took substantial steps toward alleviating these regulatory constraints in its Video Dialtone Decision, in which it defines a regulatory framework for telephone companies to offer video on a common carrier basis. Within the confines of the law, this decision permits slightly larger telephone company ownership relationships with video programming providers. To its credit, the FCC did not take a stand on technology -- the order did not dictate or preclude a specific architecture or configuration.

The FCC decision allows a company such as BroadBand Technologies, which offers an affordable, deployable technology for integrated broadband services today, to participate in the development of the network, thus supporting immediate possibilities for instituting a broadband-capable infrastructure. The FCC's Video Dialtone Decision has set the stage for American technology-based companies to invest in future research, development and manufacturing.

While this decision was an important first step, difficulties remain. First, while last year's order would presume to allow telephone companies into the video business, the proceeding is still not complete. The FCC has before it several petitions for reconsideration of various aspects of the order. There is some uncertainty surrounding the outcome of the

reconsideration given recent changes in the FCC and uncertainty surrounding the appointment of a new Chairman and Commissioner. This uncertainty in the regulatory environment only exacerbates the normal uncertainty of the business environment, and further delays the marketplace roll-out of good technology.

Furthermore, in its Video Dialtone Decision, the FCC also left unresolved many important policy issues. It indicated it would decide these issues in the context of Section 214 applications -- the section of the Communications Act under which telephone companies seek permission to construct additional facilities. If the President's plan is indeed to ensure that federal regulatory policy encourages investment in innovation and technology development, a first step would be to complete this proceeding and grant these applications.

While very important to our company, completing the Video Dialtone proceeding at the FCC is still but a limited step in the scheme of things. There is, in fact, a greater legal hurdle to scale before telephone companies can begin to offer the kinds of services your Subcommittee wishes to see in this country, and in which my company is poised to participate.

As mentioned earlier, Section 613 (b) of the Communications Act prohibits telephone companies from providing video programming within their local service areas. It seems to me, that while the FCC has acted within the confines of this law, it is the law itself that frustrates and leads the telephone companies to inaction.

This crossownership restriction has the effect of impeding innovations, such as those developed by my company, from realizing universal commercial application. While we

will no doubt see some video dialtone applications as a result of the FCC decision, the crossownership restriction tends to maintain the artificial boundaries between the types of businesses that computer and communications technologies are constantly blurring.

In the last Congress, now Vice President Gore and Senator Burns introduced S. 1200, and Representatives Boucher and Oxley introduced H.R. 2546, bills that would have removed the ban on telephone company provision of video programming, subject to certain limitations and safeguards. I urge you to complete action on these issues in this Congress.

What I just spoke of are regulatory and legal issues quite specific to BroadBand's situation. The second way government can support its goals to create a national information highway is somewhat broader, that is, to establish generally an enabling environment for technology development and commercialization. Of course, this Subcommittee is no stranger to these ideas. Let me elaborate on a few that I see as important from the vantage point of an entrepreneurial, high-technology firm.

For one, stable investment in technology requires a stable environment for business planning. Government can provide one element of this environment for firms such as ours by making permanent the investment tax credit.

Congress created this tax credit in 1981 in response to a perceived decline in R&D expenditures. Since then, Congress has extended the tax credit several times, yet not made it permanent. Certainly, this contributes to uncertainty in the investment environment. I was encouraged to see the President's technology policy plan, presented in a report known as

Technology for America's Economic Growth, A New Direction to Build Economic Growth, support a permanent Research and Experimentation Tax Credit. I hope Congress acts quickly on this. I also hope that Congress extends this credit to large companies because investment by these companies will be necessary to build the broadband networks of the future.

Government can also act to create this enabling environment in a way somewhat more specific to telecommunications, that is, to prescribe more rational depreciation schedules for telephone companies. Right now, even though the FCC has adopted "incentive regulation" for most of these companies, they are forced to depreciate their plant and equipment over such long time horizons that it tends to undermine incentives to invest. Such schedules keep the current copper in the ground and prevent a more rapid deployment of advanced technology and thus broadband services where they count -- to all Americans.

The third way that government can support a truly national, useful, information highway is to support research and development in networking applications. I endorse those provisions of the President's technology strategy that fund these, as well as Congressional, initiatives in this area.

There should be any number of socially-beneficial, yet technology-neutral applications being developed by companies such as ours. There are as many applications as there are dreamers and inventors in this country. These applications can be in health care, education, telecommuting, libraries, service for the disabled and advanced manufacturing.

An interactive broadband platform such as our own can drive this inventiveness, because it gives applications creators a basis on which to work. In this regard, I would observe that the very openness of our switched platform is particularly conducive to promoting new ideas.

An example in our own home state is VISTAnet, a telecommunications network which enables researchers at the University of North Carolina Medical Center to use computer graphics to provide sophisticated medical imaging for cancer treatment study. Researchers transmit CAT-scan images of cancer patients over VISTAnet to a CRAY Y-MP supercomputer, located in Research Triangle Park, 20 miles away. The computer produces high-definition, three dimensional graphics of the images which physicians can then use to detect tumors and radiation treatment effects at various levels within the body. This technology, thereby, allows doctors and medical students to quickly explore various options for treatment simultaneously.

Another network application in our area is Vision Carolina, a BellSouth Telecommunications educational project, designed to increase student access to specialized courses in advanced mathematics, science and languages through high-speed telecommunications. Vision Carolina comprises two separate interactive video networks that provide resource sharing among 16 different sites.

Applications research will help make the technology that is available, or can be deployed, relevant to specific human needs. Applications research should be geared to ensuring that not just institutions, but the American people benefit. Once people see how the network helps them to learn better, or better manage their lives, or to better amuse themselves,

interactive broadband network usage will skyrocket. This will, in turn, prompt greater technology deployment. Hence, seed money for network applications can help grow mighty networking trees.

Before concluding, I would like to leave one more message for this Committee. It is time to act. The technology exists. But legal gridlock and a shortage of mass market applications are slowing deployment.

Regulatory uncertainty has been our biggest hurdle. Lack of focus and investment uncertainty causes our customers to move slowly because they must vacillate between short and long term views. Coherent technology policy that sets a plan for regulatory and legal reform can go a long way toward focussing attention and driving action.

Our nation's industrial competitors are actively promoting a vision of broadband interactive network deployment. This a fundamental strategy in Japan as its policymakers believe that a national broadband infrastructure will be a key component of a national strategy to remain economically strong into the next century. France Telecom has been active in the development of video communications networks since the end of 1987 when it began constructing 50 local networks to serve nearly 300 communities. France Telecom also owns 51 percent of Telediffusion de France (TDF), the leading supplier of broadcast programming. Together, they plan to offer new audiovisual services, including pay-per-view and high definition television, over both cable and fiber networks. Germany's state-owned telecommunications carrier, Deutsche Bundespost Telekom, owns and operates both the cable and telephone

infrastructure in that country. Telekom has been constructing a national broadband network in order to facilitate the spread of ISDN services to users in metropolitan areas.

At BroadBand Technologies, where we are among the world leaders in broadband technology innovation, we are really quite concerned. We have bet our careers on a national vision of affordable, interactive broadband networks. In the five years since we incorporated ourselves, our success in the laboratory and in field trials with many customers has boosted our faith in ourselves and our technology.

But, unless legal and regulatory roadblocks are removed wisely and quickly, we may see our own corporate lead, and America's chance to lead in broadband network innovation, undermined by more Washington policy gridlock.

To summarize and conclude, I believe that BroadBand Technologies has a message of particular interest, both to the Members of this Subcommittee, who have had a longstanding interest in establishing a coherent U.S. technology policy, and to the Clinton Administration as it moves forward with its vision of a national information infrastructure. BroadBand Technologies is an American, entrepreneurial company that has developed cutting edge technology at no taxpayer expense. We can only hope to succeed in the world marketplace if we are able to deploy our technology rapidly in this market. Law and regulation should be designed to encourage innovative, entrepreneurial companies such as ours, not hold them back.

Thank you for your attention and consideration. I am happy to respond to any questions that you may have.

Salim A.L. Bhatia
BroadBand Technologies
P.O. Box 13737
Research Triangle Park, NC 27709

919-544-0015
919-544-3459 (FAX)

Salim Bhatia is cofounder, president and CEO of BroadBand Technologies, Inc. (BBT), a private company established in 1988. Previously, as Vice President of Siecor Corporation, Mr. Bhatia was responsible for Sales and Marketing as Siecor built its worldwide leadership in fiber optic cable systems. Prior to joining Siecor, Mr. Bhatia held sales, marketing, business planning, engineering and operations positions at Corning, Inc. and Esso Petroleum Company in the United Kingdom. Mr. Bhatia earned his M.B.A. at Harvard University and a B.S. in Engineering at University College, London.

Mr. VALENTINE. Thank you, sir.

Dr. Karin?

Dr. KARIN. Mr. Chairman, members of the committee, my name is Sidney Karin and I am the director of the San Diego Supercomputer Center. I want to thank you for this opportunity to discuss these issues today. Knowing that time is brief, I'm going to not read my prepared remarks, but informally summarize some of the major points.

Dr. Lindberg did a fine job of summarizing the HPCC program, and I would start off by endorsing what he had to say. And I will fill in some of the details that he alluded to from my own experience.

In recent years, high performance computing has become a vital enabling force in the conduct of science and engineering research, and, indeed, computational simulation has now joined theory and experiment, as a third way of doing science. This has been driven by advances in high performance computing technologies—hardware, software, algorithms, and communications techniques and technologies—and also by developing a trained pool of scientists and engineers.

As I mentioned before, I represent the San Diego Supercomputer Center, one of four national laboratories for computational science and engineering established by the National Science Foundation in the mid- eighties. The others include the Cornell Theory Center, the National Center for Supercomputer Applications at the University of Illinois, and the Pittsburgh Supercomputer Center.

We have moved rapidly beyond the original program goals and, in my opinion, we've played an important role in the initial development and implementation of high performance computing for the scientific research community and in the implementation of the National Information Infrastructure for the country, and for the research and education community in particular.

That progress that we've made—and I will touch on a couple of specific points in a moment—is now being accelerated through some important cooperative and collaborative efforts. The centers that I just mentioned have joined together to work in the concept of a metacenter, linking the resources of the four centers together and making something that is, forgive me for the cliche, something where the whole is greater than the sum of the parts.

In addition, we are now working also in the context of the NSF and DARPA, or now ARPA, sponsored National Consortium for High Performance Computing, which I'll talk about in a moment, and that is also greatly accelerating our efforts and enhancing these efforts.

Our technical activities and outreach programs have involved over 10,000 scientists and engineers in the very broad spectrum of scientific endeavors, from microbiology to astronomy, to zoology, to electrical engineering, physics, and so on. These researchers have produced 15,000-plus communications journal articles, books, Ph.D. theses. I'd flog my own book here, but it's out of print. And they've put great effort into putting these efforts, putting these results, in a form that is understandable. Through the use of scientific visualization techniques, we're producing not just books and journal articles, but animation and videos that facilitate scientific interchange

much, much better than in the past and also communication to the public of these results.

These communications efforts extend into the classroom. The scientific community has been developing university curricula and degree programs to prepare the next generation of computational scientists, formalizing these new technologies in our universities, and the NSF centers have been working together in introducing these technologies into the K through 12 arena by connecting schools to the Internet, by teaching students about the resources and giving them hands-on experiences, but, more importantly I believe, conducting special computational training programs for science and math teachers.

I must mention one in particular that we have recently begun in San Diego called the Supercomputer Teacher Enhancement Program, funded by the National Science Foundation, which will be a several-year-long program to do in-depth work with a significant number of high school teachers to improve their skills in these very new technologies, and I'm pleased to note that it is particularly focused on those teachers working in schools that have a predominant classroom made up of underrepresented minority students.

Now let me mention a few of the successes of high performance computing that have come from the program to date. Since I was asked to talk about high performance computing, I feel constrained to mention a few.

Scientists, using these NSF centers, have modeled the formation of ozone in the Los Angeles Basin and successfully modeled that process and actually led to changes in the regulatory environment to improve the air quality in Los Angeles. And, of course, those techniques are generalizable to other places.

At my own center, we were able to successfully model a recent damaging sewage spill in the ocean, and generate useful information for sewage outfall engineering to prevent that sort of thing in the future and to mitigate such damages.

Many groups are working on simulating regional and global climate change, and on the processes that lead to earthquakes and other such phenomenon. In addition, there are many specific medical applications that result from high performance computing that have been—they are described in my written testimony, which I will not go into in detail here.

I want to mention another class of activities where we have worked with U.S. industry. Alcoa, for example, working with our sister center in Pittsburgh, was able to successfully design a more durable and a less expensive aluminum can that can withstand harder impacts.

My own center, working with GenCorp, was able to help them design a more sturdy automobile body. The Illinois center, working with the Caterpillar Corporation, designing heavy equipment; the Cornell Theory Center, working with Dow Corning on the chemistry of glass—all of these are not just theoretical research efforts, but, in fact, practical efforts relating to products and services in the marketplace today.

Beyond those industrial collaborations, our centers have worked with the vendors of computers and have established relationships with nearly all of the players in the high performance computing

industry today. My own center recently installed an Intel Paragon, the latest and most powerful of those kinds of machines, massively parallel scalable architecture machines. Others, such as NCSA, have recently installed a machine from Thinking Machines; there's a KSR machine at the Cornell Center; we also have an Ncube. There are plans for other machines, such as the new IBM machine, and the Cray machine within the context of the metacenter. Our work is not simply to install the machines, however. We've worked with these vendors to help prototype and assist with the design and software development for these machines, and we continue to do so.

At this point, as I'm running out of time, I'd like to return to the NCHPC, the National Consortium for High Performance Computing, and describe it slightly more fully. It arose within the past year. Our center joined more than a dozen other institutions, including our sister NSF centers, several government laboratories, Army, Navy, Air Force research laboratories, and a number of other universities to form this consortium. Major sponsorship comes from a partnership of ARPA and the National Science Foundation. And the goal is to accelerate the development, dissemination, and application of high performance computing technology, with special relevance to problems of great scientific, societal, and national security interest.

Our efforts in this consortium are now being expanded to include other entities, such as the several state-sponsored supercomputer centers and research institutions, embracing far more organizations throughout our society, in trying to cover the various sectors of the high performance computing community and also the various sectors of our society that can benefit from these activities, as we march on developing machines that are thousands of times more powerful than the ones we have today.

I should note, Mr. Chairman, that one of these state centers is the North Carolina Supercomputer Center, which I believe is in your district. Also, of course, the University of North Carolina is affiliated with the Cornell center I mentioned and also, I believe, with the Pittsburgh center.

We are establishing very concrete links with these centers. In fact, we've already worked with the North Carolina center to take the video teleconferencing expertise developed in that center, and which has now been implemented and is in place. I used it earlier this week in preparing my testimony. It now includes not just the North Carolina center, but the four NSF centers and NSF Headquarters are linked, and we're exploring ways to broaden that activity. And we look forward to further collaboration. What's under discussion, or actually under planning stages right now is an effort involving scientific visualization with two of the national centers and the North Carolina center.

I need to mention a number of other things that I just don't have time to do. Let me proceed to a conclusion by noting that the HPCC program, which I believe is the real underpinning of the National Information Infrastructure effort that is now under discussion, is only about halfway through its initial five-year phase. And while tremendous progress has been made, it's necessary that we vigorously stay the course, and at the same time we must be care-

ful to be flexible. The underlying technologies of high performance computing—and, indeed, computing more generally—are evolving at an unprecedented rate. As Dr. Lindberg said, this is a very, very exciting scientific endeavor, one of the most exciting, not just I believe in our time, but going back, I believe that this may have the largest impact on our society since the Industrial Revolution. In fact, referring to this activity as a "digital revolution" is in no way an exaggeration of the potential impact upon our society.

Clearly, the activities that I have been directly involved with, funded by the Science Foundation and DARPA primarily, have led to phenomenal results to date, and I urge the committee to see to it that these agencies are adequately funded.

I did not comment explicitly about S. 4 in my remarks, but I would say that I would like to see S. 4 strengthened somewhat in its focus on high performance computing. It seems to be focused more on some of the delivery mechanisms for the technology, and I want to make sure that technology itself continues to be supported in a manner that will allow us to sustain this revolutionary growth in the activities.

And I think with that, I will—well, one last remark I'd make about S. 4, is that centers such as the ones that I have been describing, and consortia such as the National Consortium for High Performance Computing are existing mechanisms that are implementing many of the goals of S. 4. I don't mean, by any means, to declare victory, but to suggest that new entities and new mechanisms are not needed, but support for the existing ones I think is entirely in order.

And, with that, I thank you again for the opportunity. I'd be pleased to answer questions at the appropriate time.

[The prepared statement of Dr. Karin follows:]

Statement to the

House Subcommittee on Technology, Environment and Aviation

by

Dr. Sidney Karin
Director
San Diego Supercomputer Center

March 25, 1993

Mr. Chairman and members of the subcommittee, my name is Sidney Karin, and I am the director of the San Diego Supercomputer Center. Thank you for this opportunity to discuss these important issues related to developing national technology policy priorities. The issues for today's discussion, the status of high performance computing programs and the coordination processes now being undertaken to facilitate collaborative projects, are indeed important when determining priorities in the months and years to come.

In recent years, high-performance computing has become a vital enabling force in the conduct of science and engineering research. Unquestionably, computational science and engineering has joined, and, in many instances displaced, the traditional methods of theory and experiment. This trend has been powered by advances in high performance computing hardware and software, the development of more efficient computational methodologies and algorithms, the spread and enhancement of the national communications network, and the growth of a trained pool of scientists and engineers.

As I mentioned before, I represent the San Diego Supercomputer Center (SDSC), one of four national laboratories established by the National Science Foundation in the mid-1980's for computational science and engineering. SDSC and its sister centers -- the Cornell Theory Center (CTC), the National Center for Supercomputing Applications (NCSA), and the Pittsburgh Supercomputing Center (PSC) -- have moved rapidly and comprehensively beyond the original program goals. Moreover, in my opinion, we have played an important role in the initial development and implementation of the emerging national information infrastructure for the country and, in particular, for the research and education community.

The progress made to date is now being accelerated by the emergence of some significant cooperative, mutually supportive activities. These include the national MetaCenter, initiated by the four NSF supercomputer centers and the National Consortium for High-Performance Computing (NCHPC) sponsored jointly by NSF and the Defense Advanced Research Projects Agency (DARPA) which I will discuss more fully later.

Our technical activities and outreach programs have involved over 10,000 scientists and engineers. working in a broad spectrum of scientific endeavors in astronomy, atmospheric science, biochemistry, biology, chemistry, earth sciences, electrical engineering, materials science, mechanics, oceanography, and physics. These researchers have produced some 15,000 communications about their work, including journal articles, books, Ph.D. theses, and conference presentations. To communicate their results visually -- which, when faced with hundred of pages of output data from a simulation, is the only effective communications tool -- the researchers have used the techniques of scientific visualization for still images and animations from the computational simulations they have performed.

Such communications, of course, extend to the classroom. The scientists have begun incorporating their computational knowledge into university curricula and degree programs to prepare the next generation of computational scientists. The NSF supercomputer centers, in recognition of the fact that education doesn't begin with undergraduates, are paying significant attention to the needs of grades K-12 by supporting creative and inexpensive ways to connect schools to the Internet, teaching students about the informational resources on the network, and conducting special computational training programs for science and math teachers. The goals here are to promote professional development for the teachers as well as encourage students to take greater interest in science and math, and, hopefully, to think about college and their careers beyond.

SDSC, for example, has begun a NSF-funded, multi-year "Supercomputer Teacher Enhancement Program" (STEP) to help high school math and science teachers learn about and incorporate the basis of supercomputing and computational science into their classrooms. STEP emphasizes acquisition of computational science skills and the accompanying pedagogy necessary for teaching computational science, especially to underrepresented minority students.

At this point, I would like to cite a few examples of successful ventures for the attention of the committee to illustrate the value of high-performance computing:

* Scientists have modeled the buildup of ozone above the Los Angeles basin to identify high-emission regions and recommended abatement policies.

* A sewage spill off the coast of San Diego has been modeled, providing important information about sewage outfall engineering as well as sewage containment and cleanup. Similarly, scientists have demonstrated the effects of tides, currents and atmospheric conditions on the distribution of pollutants in San Francisco Bay.

* Various groups are simulating regional and global climate, trying to understand the interactions between coupled atmospheric and oceanic processes or specific problems such as the periodic development and dissolution of the ozone over Antarctica.

* Scientists are studying fluctuations in the Earth's gravity field to better understand the formation of the Earth's surface and the movement of continental plates.

* Chemists and materials scientists are studying the structure of various molecules to better understand their properties better and evaluate their potential for use in synthetic materials.

* One medical team is reconstructing ultrasound fetal data computationally into 3D images to check "noninvasively" for prenatal birth defects.

* Some researchers are looking at the coiling and knotting processes of DNA, which have implications for fundamental biological activities such as replication, transcription, and recombination.

* Others scientists are calculating the stress exerted on developing bones -- believe it or not, one area where stress has been shown not only to be a good thing, but crucial to proper development.

Beyond these many important activities in computational simulation using supercomputers, the role of the centers has evolved in a number of other directions such as pioneering complementary technologies, including scientific visualization, large-scale data storage systems, and high-performance communications systems, to name only a few. Several companies have been formed as direct spinoffs from these centers, while others have worked with the centers as a crucial part of their evolving businesses.

In addition to these projects, we are also introducing other activities such as industrial partnerships, whereby companies have leveraged government-sponsored research into private-sector products. Through such partnerships we are introducing industry to high-performance computing technologies, and teaching their staffs in the efficient use of these resources. Such collaborations include:

* Alcoa teaming with the Pittsburgh Supercomputing Center to design a more durable aluminum can that can withstand harder impacts;

* GenCorp collaborating with my own center to created a more sturdy Corvette car body;

* NCSA's affiliating with Caterpillar to design heavy equipment, thus requiring expensive field tests of only the best computer-predicted designs;

* CTC's working with Dow Corning to predict the chemistry of glasses, saving millions of dollars annually related to glass imperfections;

* SDSC's linking with Solar Turbine and Sundstrand Corporation to design -- or redesign -- expensive engine parts.

Vendor Cooperation

Beyond the interaction with the industries whose use of computers is in the creation of their products and services, we have cooperative research and development programs with every major vendor in the high-performance computing field. At our own center, we are currently working with Intel on the development of the operating system needed to efficiently and effectively manage their newest and most powerful scalable parallel computers. Just a few weeks ago, the latest example of this technology, an Intel Paragon, was installed at SDSC. Earlier, a Thinking Machines CM-5, was installed at NCSA, a KSR machine at CTC and a nCube at SDSC. Plans are also in place for implementation of the newest IBM and Cray scalable parallel machines to be installed in the MetaCenter. Much of this activity has been made possible through support from NCHPC and DARPA, the entities I mentioned earlier.

Our work with the vendors of high-performance computers includes experimenting with prototype equipment and the development of system software as noted above. In addition, our scientists are performing the necessary research to discover the necessary algorithms and to develop the necessary applications software to make these machines easier to use as effective tools for science and engineering. These activities are critical for assuring the continued U.S. lead in this critical enabling technology.

At this point, I would like to return to the NCHPC collaborative efforts I mentioned earlier. Besides taking a leadership role in developing MetaCenter cooperative efforts during the past year, SDSC joined more than a dozen institutions -- our sister NSF supercomputing centers, government laboratories, Army, Navy, and Air Force research laboratories and several additional universities -- to form the National Consortium for High Performance Computing. With major sponsorship from a partnership of the Defense Advanced Research Projects Agency (DARPA) and the NSF, the NCHPC seeks to implement several objectives, the first of which is to accelerate the development, dissemination, and application of high-performance computing technology with special relevance to problems of great scientific, societal, and national security interest. For this to happen, a critical mass of scientists must be educated so they can educate us.

The four centers, working together with the MetaCenter and NCHPC, are more effective than they might be as independent institutes. As a result, our efforts are being expanded to include other entities such as several state-sponsored supercomputer centers and research institutions, embracing yet many more players and many more institutions. The broad range -- and the scale -- of current and evolving high-performance computing and communications technology requires an equally broad spectrum of local, state and national facilities. Our activities, therefore, are being extended to encompass virtually all sectors of the high-performance computing community and to additional sectors of society, including, importantly, the K-12 education community.

This consortium will continue to provide access to high-performance computing systems capable of scaling from billions to tens of trillions of operations per second. As a result, the use of these systems will be increased dramatically by implementing them as part of larger distributed, heterogeneous systems whereby machines of different architectures are linked and their combined resources applied to solving individual problems. This becomes possible now only through the implementation of the national information infrastructure itself and the cooperative, mutually supportive nature of the interaction among the NCHPC members. This paradigm will effectively increase the resources available to the largest, most demanding scientific problems facing society today. Moreover, the consortium will stimulate cooperative research among government academia, and industry on problems of mutual interest and, as a focal point, bring interdisciplinary teams of scientists together.

One cooperative project with a state center, for example, involves the North Carolina Supercomputer Center (NCSC), which I believe is in Congressman Valentine's district. (Also, the University of North Carolina is a Cornell Smartnode and a member of the Pittsburgh Supercomputing Center academic affiliates.) Key to this collaborative effort is a new video teleconference network linked to NSF headquarters and MCNC which operates the North Carolina Supercomputing Center. This system is already in use. In fact, I used the system earlier this week when preparing for these hearings. We have also initiated interactions in areas of parallel supercomputing and scientific visualization.

In this context, another encouraging project should be mentioned: Project Sequoia 2000. This project is a Digital Equipment Corporation-funded collaboration among University of California campuses, the San Diego Supercomputer Center, state and federal government agencies, and private industry to develop an advanced information system to enhance productivity of global-change scientists. We are working to create a convenient visual interface to a wide spectrum of global-change data obtained through techniques, including remote satellite sensing and computer modeling. At the same time, Sequoia 2000 researchers are extending current database and mass storage technology to accommodate the enormous volumes of data involved. Beyond the obvious application to pressing environmental questions, tools developed here will have application to a broad range of scientific disciplines.

The HPCC program is only about half way into its initial five-year phase, but it has clearly become the foundation for the national information infrastructure. (In fact, SDSC hosted the original interagency FCCSET meeting that produced the report that led to the establishment of the original HPCC program.) The interagency NCHPC is clearly an important mechanism to promote the development of an improved information infrastructure.

Tremendous progress has been made, but we must continuously – and vigorously – stay the course. While doing so, we must remain flexible in our approach. The underlying technologies of high-performance computing, indeed of computing itself, are now evolving at an unprecedented rate. Entirely new applications will result from computing technology now under development and the adoption of these technologies by vast new sectors of our society as NCHPC seeks to foster will have important benefits for our society. NCHPC is already expanding its membership so that all relevant sectors of society will be represented. Already a number of working groups are working on such projects as a national file system and data archive system, as well as specific software for specific applications for scalable parallel architecture. Policies need to be flexible to best accommodate this growth and development.

With these significant developments, the research community is no longer bound by the constraints of single laboratories, but can take advantage of distributed intelligence and machinery, seamlessly networked together. Building such a national computational environment in these times of belt-tightening is clearly the responsible way to use our resources to transform engineering and scientific methodologies, and give American companies a technological edge in the global market.

We are working through mechanisms like the MetaCenter and organizations such as NCHPC to include more universities and laboratories. There is a need to install small systems at institutions for use locally and in conjunction with larger machines at most centralized facilities like SDSC. This paradigm will fill the need for convenient access to parallel architectures for learning as well as algorithm and software development while maintaining national resources to support the largest and most specialized scientific projects. It would also provide a more distributed pool of expertise around the country.

Further, it would give researchers early access to new computing systems, important to gain experience that will guide future research decisions and efforts. Nevertheless, we must stay one step ahead with earlier experimentation and evaluation of the systems to provide critical feedback to vendors and reduce any false starts on the part of the scientists. We also must continue our outreach efforts to educational and industrial communities to focus all of our efforts so we can build on each others' results and technologies,. For by doing so, we will be able to enhance the sophistication and efficiency of the most experienced user and continue extending the supercomputing frontiers to accommodate those who have yet to appreciate the benefits of this technology.

Clearly, NSF and DARPA support has led to phenomenal high-performance computing accomplishments. It is important the agencies continue to work together, supporting the NCHPC, and I urge the committee to see to it that these agencies are adequately funded. The country's scientific effort must continue to have strong government support to encourage the use of cutting-edge technologies which, in turn, will create a digital revolution. With your support, we will have the expertise to help America compete successfully into the next century. With the development of advanced computing environments -- scalable, parallel computing; high-speed, large-capacity networking capabilities, and increasingly sophisticated and powerful software tools -- the science and engineering community will be capable of solving currently intractable problems now considered intractable, the so-called "Grand Challenges" of science, which will materially improve our way of life.

Conclusion

Mr. Chairman, the digital revolution, of which high-performance computing is only a part, is just now getting under way, yet this revolution promises to dwarf the industrial revolution itself. In fact, the pace of change we have seen in the past decade in all phases of computing will actually be insignificant with the progress that is inevitable in the next decade.

I predict the HPCC program will have great impact on the country's economy if it is support by a strong, sustained budget. By accelerating technology transfer, by bringing together the research, engineering design, and manufacturing sectors, we are creating a high-technology synergy, if you will a sure formula to fueling a strong national economy. And, as we bolster our high-technology and educational infrastructures, we will have provided a strong foundation for great benefits for many years to come.

I agree with a recent White House reminder: While change is certain, progress is not. Together – Congress, the Executive Branch, the research community, and industry – we can determine the direction the change will take. My colleagues and I at SDSC looking forward to contributing our part to this important and exciting adventure.

Mr. VALENTINE. Thank you, sir.

We will have to suspend for another few moments, with apologies. We hope that another member of the subcommittee will show up shortly, so that we don't have to expend another 10 minutes or so. But if you would bear with us, we'll get back to this in just a moment or two.

[Recess.]

Mr. VALENTINE. We'll get started. We'll get back down to business.

I think that we are down—we are to the testimony of Dr. Gage.

Mr. GAGE. I appreciate the opportunity to testify before this committee today.

I'm president of the Cleveland Advanced Manufacturing Program, CAMP, which is a not-for-profit corporation established by Cleveland's business leaders in 1984 to help improve the competitiveness of regional manufacturers. CAMP's one of the eight Ohio Edison Technology Centers and accomplishes that mission by conducting research, development, deployment, and training programs in association with local universities and colleges.

In addition, CAMP operates the Great Lakes Manufacturing Technology Center with the support of the National Institutes of Standards and Technology, NIST. One of the first three centers established by NIST in 1989, our Great Lakes Manufacturing Technology Center primarily focuses on helping small and medium-sized businesses, by deploying and transferring technology to them. We encourage and support these small companies in modernizing their business practices, plant equipment, and workforce, thus improving their competitiveness.

Now, as the nation's manufacturing extension efforts expand, a national electronic information network will be critical in supporting the manufacturing assistance and training programs across the country. A high quality, broadband communications network would ensure rapid and effective communication among these Manufacturing Technology Centers and similar organizations. There are now seven MTCs nationwide. They will expand very rapidly in number over the next few years.

A national network would also facilitate the rapid discovery of appropriate resources to help solve the problems of individual small companies, but, most importantly, it could help connect the small companies themselves, with service providers, and with one another.

The MTCs are required by NIST to be linked into Internet. MTC employees are able to communicate with their peers across the country through electronic mail. NIST, as well as other governmental offices and universities, have connected into this network, which is serving the MTCs very well today, but it is only a first step.

The MTCs face three clearly identifiable tasks in electronic communications. The first is the development or adaptation of software, hardware, and procedures to support integration and availability of resources across the MTC network. For example, a California MTC engineer visiting a client's plant would like to explain, in real time, his client's machine tool fixture problem to a technical expert which works with the Cleveland MTC. However, at the time

of the inquiry, the Cleveland expert is working in a plant in western Pennsylvania. The challenge is clear. The individual technologies are available. However, affordable integrated systems to answer these needs are not.

In a promising experiment, Tufts University, in cooperation with the Northeast MTC, has developed a bulletin board and information service network called TECHNET. Its operations are now being expanded to help link all of the MTCs. It could also be a resource to manufacturers nationally. As part of this experiment, TECHNET is being made available, at no cost, to small manufacturers in the southern New England states and New York. This is an important development.

The second task MTCs face is providing assistance to small manufacturers in dealing with electronic commerce issues. Companies need help in planning, purchasing, integrating, and trouble shooting their in-house communications systems, as well as the interfaces with other companies and national networks. These small manufacturers also need help in dealing with specific customer product information data; for example, computer-aided design files, sent to them in formats not compatible with their own systems, and in achieving compatibility in the future.

The third task for the MTCs is to provide a mechanism for individual companies to be served directly by a computer network. Such a network would enable companies to directly access information databases and specialized bulletin boards covering job quote opportunities, available capital equipment, new regulations, et cetera. The network would be regionally updated by individual MTCs, and similar organizations, to respond to the needs of their clients.

The current network, which is supporting the Department of the Defense's computer-aided acquisition and logistics test network, and is assisting companies in learning how to translate technical data into manufacturing data, is very much in need of a broadband telecommunications network available to many more manufacturers.

We've helped local manufacturers fabricate parts over this network from computer data, without ever converting the data to paper form. We've also found that many small companies need similar help in making data conversion for the automobile industry. But this current network is woefully inadequate. It really can handle only about 3,000 users, but there are 14,500 manufacturers alone in northern Ohio. So you can see the mismatches there.

Further, connection to this network is technically complex and relatively expensive for smaller companies. Only larger companies and governmental institutions can afford to use these resources now. Consequently, one of the most significant undertakings yet remaining is the establishment of a local manufacturers' network providing affordable access to one another, and then to the emerging information superhighways. These local networks would include mutual problem-solving and information-sharing among the companies, as well as access to public and private service providers. We think that by stimulating collaboration among the small companies these networks can help restore the leadership of U.S. manufacturing.

Thank you very much.
[The prepared statement of Mr. Gage follows:]

STATEMENT OF STEPHEN J. GAGE
BEFORE THE SUBCOMMITTEE ON TECHNOLOGY,
ENVIRONMENT, AND AVIATION
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
MARCH 25, 1993

My name is Stephen J. Gage. I am president of the Cleveland Advanced Manufacturing Program (CAMP) in Cleveland, Ohio. CAMP is a not-for-profit corporation established by Cleveland business leaders in 1984 to improve the competitiveness of regional manufacturers. One of the eight State of Ohio Edison Technology Centers, CAMP accomplishes its mission in part by conducting research, development, deployment, and training programs in association with local universities and colleges.

In addition, CAMP operates the Great Lakes Manufacturing Technology Center (GLMTC) with the support of the National Institute of Standards and Technology (NIST). One of the first three centers established by NIST in 1989, GLMTC primarily focuses on transferring or deploying technology to small and medium-sized manufacturers (SMMs). GLMTC's services encourage and support SMMs in modernizing their business practices, plant, equipment, and workforce, thus improving their competitiveness. To help SMMs, GLMTC provides a range of awareness raising and educational events (seminars, workshops, demonstrations, etc.); a cadre of field engineers who visit and assess SMMs and help them initiate modernization projects; and a select group of technical experts who assist the companies by managing these projects. In addition to its own resources, GLMTC utilizes external resources at local universities, in the private sector and at other MTCs.

The Communications Revolution

Today we think of the telegraph as a primitive means of early communication. In the future, we will doubtlessly think similarly of our present telephone, television and cable television networks. We are now well into the Communications Revolution. Technology is exploding. Computer hardware and user-friendly software, telecommunications, fiber optics, satellites, and publishing technologies are merging to offer immediate access to information to anyone. That access may be through the familiar twisted pair telephone line, cable TV coaxial cable, a fiber optic line, a signal beamed directly to and from satellites, a mobile phone, or a personal communications device.

Until recently, only a small fraction of the technical elite have been able to master the intellectual and physical barriers enabling communication between man and machine. While there is now considerable promise, the information superhighway (the necessary infrastructure) is still not complete. Also missing is a broad understanding of the advantages many SMM users could enjoy if they exploited this infrastructure. Completing the infrastructure and introducing it to a reasonable fraction of the nation's 350,000 manufacturers present many challenges.

The MTCs and Communications Networks

As the nation's manufacturing extension efforts expand, a national electronic information network will be critical in supporting manufacturing assistance and training programs across the country. A high quality broadband communications network would ensure rapid and effective communications among MTCs and similar organizations. There are now seven MTCs; they will likely expand rapidly in number. A national network would also facilitate the rapid discovery of appropriate resources to solve the problems of individual SMMs. But most important, it could help connect the SMMs themselves with service providers and with one another.

The MTCs are required by NIST to be linked into INTERNET, an international computer network which originated with the Department of Defense. MTC employees are able to communicate with their peers across the country through electronic mail. NIST, as well as most government offices and universities, are connected into INTERNET. While INTERNET is serving the MTCs well today, it is only a first step.

The MTCs face three clearly identifiable tasks in electronic communications. The first is the development or adaption of software, hardware, and procedures to support improved integration and availability of resources across the MTC network. For example, a California MTC field engineer visiting a client's plant would like to explain in real-time his client's machine tool fixture problem to a technical expert who works for the Cleveland MTC. However, at the time of inquiry, the Cleveland expert is at a plant in Western Pennsylvania. So beyond determining who the best expert is, there are a number of other challenges: determining where the expert is currently located and whether he can be interrupted; establishing timely audio and visual communications with him; providing appropriate credit and compensation to the expert and his host institution; etc.

The second task MTCs face is providing assistance to SMMs in dealing with electronic commerce issues. Companies need help in planning, purchasing, integrating, and trouble-shooting their inhouse communications systems as well as the interfaces with other companies and national networks. SMMs also need help in dealing with specific customer product information data (e.g., Computer-Aided Design files) sent to them in a format not compatible with their own systems and in achieving compatibility in the future. More about this issue later.

The third task for the MTCs is to provide a mechanism for individual companies to be served directly by a computer network. Such a network would enable companies to directly access information databases and specialized bulletin boards covering job quote opportunities, available capital equipment, new regulations, new technical support resources, and upcoming workshops. The network would be regionally updated by individual MTCs to respond to the needs of their clients.

In a promising experiment, Tufts University in cooperation with the NorthEast MTC (NEMTC) has developed a bulletin board and information service network called TECNET. Its operations are now being expanded to help link the NIST MTCs and could be a resource to manufacturers nationally. As part of this experiment, TECNET is being made available to manufacturers in the southern New England states and New York. Companies are given free access to the service allowing them to communicate with the Manufacturing Resource Center at Tufts and with technical specialists at NEMTC. In addition to users being able to post questions and receive answers from staff, they also receive information from other network users. TECNET has purchased a number of databases, including governmental posting for RFP's, Military Specifications, used manufacturing equipment listings, etc., and is making them available at no extra charge to network users. This is another important step forward.

CAD Data Interchange

As suggested earlier, a major communications deficiency between engineers, managers, and operations personnel at different companies arises from the plethora of different computer systems, both hardware and software, used to capture data, perform analyses and present usable information. In product development, the use of Computer-Aided Design (CAD) provides some useful insights in the nature of these problems. Once the product is designed and converted to bits and bytes, this information can be communicated to and shared by the companies who will quote on and ultimately manufacture the product. This would be simple if all designers used the same CAD system. However, there are many commercial systems with varying capabilities to meet the widely different needs of designers and manufacturers.

The GLMTC working with the other NIST MTCs have compiled data on over 300 CAD systems. Using a features matrix developed from this compilation, the MTC's are now able to assist manufacturers in selecting a system best suited to their specific engineering and production requirements.

But this is just "the tip of the iceberg" in getting the product model converted into the final physical product. A major hurdle is the communication of the computer model from the design engineer to the manufacturer and ultimately to the SMM suppliers who perform most of the hands-on production. Since most large companies have many suppliers and most suppliers produce for several larger companies, the inter-communication problem often becomes overwhelming.

In order to overcome this problem, the CAD industry itself has attempted to develop standards which would allow data from one system to be converted and understood by other systems. The Initial Graphics Exchange Standard (IGES) and subsequent Product Data Exchange Standard (PDES) have made important progress towards interchange of design data between manufacturers using different systems. However, the standards established initially had ambiguities and discrepancies which led to accuracies in designs transferred between systems. In fact, automatic conversion between the best systems results in only about 90% effectiveness. Completion of the conversion (remaining 10% of the data) still requires tedious manual steps. Further, because the standards have been continually evolving, many CAD system developers have not tried to make their systems fully compatible with the standards. Finally, since these standards are for the U.S. only, significant problems arise in dealing with offshore suppliers.

The ultimate standard, therefore, must be complete, agreed to by all vendors and manufacturers, and international in scope and acceptance. Two weeks ago, as the result of hundreds of man-years of concerted effort, the International Standards Organization (ISO) with representatives from 30 countries including the U.S. approved the introduction of an international standard called STEP (STandard for the Exchange of Product model data). This important development will finally set the direction for communication of electronic design data between companies and even between countries.

Business Data Interchange

A similar problem exists for the exchange of business data within and between companies. This data includes inventories, work schedules, shipping information, materials and manufacturing costs, and production status. Additionally, it includes marketing, management and financial information. GLMTC has compiled key data on over 250 available business systems which companies can use to support their business operations. Using this data, GLMTC assists SMMs in determining their information and analysis needs and in selecting the appropriate business system to meet those needs.

Emerging are a number of "standards" to facilitate business data communication. The most viable of these is the Department of Defense's Computer Acquisition and Logistics Support System (CALS) program. This cross-agency operation, now being coordinated by the Air Force, is creating a standard for computer documentation and communication of business data including documents, manuals, orders, billings, quotes, and other pertinent information. CALS Shared Resource Centers (CSRC) are being developed to aid in the deployment of this standard. Especially important is the transfer to SMM manufacturers in the supplier chains. The MTCs networked to small companies are natural allies to support the CSRC activity.

GLMTC has also extended electronic commerce to a limited number of SMM manufacturers in Northeast Ohio. By providing linkages to the CALS Test Network and assisting in the conversion of technical data, GLMTC has helped local manufacturers fabricate parts from computer data without ever converting the data to paper form. Once the network connection to the manufacturers was debugged, the process has become routine, providing extremely rapid turnaround and high accuracy. GLMTC has also been providing similar data conversion services for SMM suppliers to the automotive industry.

The current network involved in this linkage is not sufficient to serve more than a few thousand users. There are over 14,500 manufacturers in Northern Ohio alone. Further, connection to the network are technically complex and relatively expensive for SMM companies. Only larger companies and governmental institutions can afford to use these resources now.

Consequently, the most significant undertaking yet remaining is the establishment of local manufacturers' networks providing access to one another and then to the information superhighways which are emerging. These local networks could include mutual problem solving and information sharing among manufacturers. By stimulating collaboration among SMMs, they can help restore the leadership of U.S. manufacturing.

A natural approach would be to develop local networks linking together users with a gateway to the large networks. Local networks may be based geographically, by interest, by product or process type (i.e. automotive, stamping, plating, electronics), or by skill type (engineering, design, finance, marketing, general management). Local networks could be formed as consortia in which all users contribute to the cost of network operations as well as the cost of interconnect and database user charges. However, at this time, the cost of establishing a network and user base is prohibitively high for SMMs. Today it would be difficult to get users, who are unaware of the effectiveness and advantages of the technology, to make significant investments based on undemonstrated claims. A significant public investment would probably be necessary to provide awareness, demonstration, training, and even trial use of the system in order to get the SMM manufacturers, who would most benefit from this technology, to actually participate.

Mr. VALENTINE. Thank you, sir.

Dr. Rodgers?

Dr. RODGERS. Thank you very much for this opportunity to speak. I will also depart from the lengthy written testimony to give an abbreviated oral version.

This is a three-nanosecond, 4,000-bit static RAM, the fastest in the world. It's used in Cray-type supercomputers. This is a SPARC processor, 512 of which are used in the Thinking Machines massively parallel supercomputer. This is, for those of you who haven't seen it, what a chunk of the electronic data highway will look like: a board which converts electrical signals into light signals, and vice versa, for taking data on and off the highway.

My company makes all of these products, and we stand to make a fortune in subsidies based on this legislation, but I'm here to tell you that Cypress Semiconductor and I do not want subsidies for supercomputing or electronic data highways, because those subsidies represent tax-and-spend economics, a known failed path, and it will hurt all American companies.

[Applause.]

Okay, thank you. That's the first time that's happened. Blew me out. Okay.

[Laughter.]

I'd like to talk about funding of supercomputers in the context of three big misconceptions I'm finding here in Washington. Misconception number one is that Silicon Valley lines up unanimously behind the Clinton technical and economic programs. We do not. You have all seen the images of John Sculley standing next to the First Lady at the State of the Union and assumed we all stand behind him in that regard. We do not.

To find out exactly what the sentiments were, I called 11 people last week, CEOs of high-tech companies, and said to them, "What do you think?" Eleven for 11 said no; 10 said no for the record; it's included.

Some excerpts: Don Valentine, venture capitalist. director of Apple Computer when Apple was brand-new: "Don't assume that John Sculley speaks for Silicon Valley. We do not need pretenders who speak for us."

"To Washington I say, please do not help us."

Finis Conner, head of Conner Peripherals, the largest disk drive company in Silicon Valley and the fastest-growing in its first five years in the United States: "President Clinton's proposed tax program will raise the U.S. corporate tax...and accelerate the move of U.S. jobs offshore. There are plenty of countries that will welcome these jobs" with tax breaks, not tax increases.

Gil Amelio, president of National Semiconductor who, although he works on technology policy, said: "Our current tax code encourages and instigates class warfare. Today, the top 5 percent of all wage earners pay 44 percent of all income tax—and if Mr. Clinton has his way this will increase further" in the future. He wants to punish with high taxes those who have built America's high-technology industries.

We don't support unanimously the Clinton program, far from it.

Misconception number two, soaking the rich, those rich companies who took a free ride in the eighties, to quote Secretary Reich,

and those of us who prospered unevenly in the eighties, to quote the President, is a good way to fund government programs. Tax and spend: you get; we pay, the bad guys.

Who are the bad guys? Let me re-introduce myself. My name is T. J. Rodgers and I am an excess of the eighties. During the eighties, I became a millionaire on paper eight and a half times over by starting a company with one employee and building that company over a decade to a billion dollars in sales, $200 million cumulative taxes paid directly and indirectly, 1,500 jobs and $300 million in exports. If those are the excesses of the eighties, let's have more of those excesses.

And what have I done with my money? I've taken my money and invested it back in Silicon Valley, intelligent investments. In my testimony, in the appendix, you will see listed 99 high-technology companies in which I am personally invested. The bold-faced ones, 19 of them, work directly on the data superhighway, the real data superhighway, the one that's going to actually be the pieces of the system, and supercomputers.

If you take money from me in the form of higher taxes, I'm not going to sell my 1989 car. I'm going to do the only thing I can do; I'm going to sell some of that stock, take money out of those high-technology investments, and give it to the government for a program. I would be willing to bet, if you were betting your own personal money, that you would put it with my portfolio as opposed to the government program to support these industries. But it's coming out of me and going into them.

The third misconception is that government subsidies are an effective way to bring high technology on. This is not true. Let's talk about supercomputers. Why don't we just have a few technologically superficial meetings; declare MasPar to be the winner—I guess, I'm sorry, not MasPar—Thinking Machines to be the winner, and the guy on my left here would be very concerned about that; go fund it and go back it happen? The answer is the supercomputer industry is too complicated to make decisions like that.

We have people who say massively parallel is the way to go. We have other people who say Cray-like machines are the way to go. We have Scott McNealy in Silicon Valley saying desktop systems, with one-tenth the power of the Cray, is the way to go. And down in Texas we've got a company called Convex, saying mini-supercomputers are the way to go.

The original founder of Convex, chairman of the board of directors, L. J. Sevin, has said about the supercomputing industry, "The supercomputer market is changing dramatically because the nature of the technology is changing. The only thing government can do is get out of the way of that change unless we want disastrous results."

I do not believe that the government picking winners and losers, to use a phrase, is the right way to go, because you will inevitably make the wrong decision; because even if you make the right decision, two weeks from now it will become the wrong decision.

So in 30 seconds, what is my good answer for an opposition plan to tax-and-spend programs? I have a message from the past, from a Democratic President who came in with high energy, who

dropped taxes and created an unprecedented boom when he was elected. John Kennedy said, "A rising tide lifts all boats." That's what you need to do.

Instead of getting yourself tangled in the intricacies of which supercomputer company, or which industry, or which center is the right way to go, create an infrastructure of the economy that rises all boats, all companies, so that we can all compete fairly with our foreign competitors.

We must stop deficit spending, number one on my agenda. It's the only thing. You could tell me it will raise your taxes and we'll have a zero budget deficit, I would say, "I'll eat it." That's the only thing.

We have a Democratic President and we have a Democratic Congress. Give President Clinton the line item veto and turn him loose. Have a balanced budget amendment to guide him to zero deficit by 1998, as outlined by the Cato Institute.

And, finally, better than I can say it here, pass the Fundamental Competitiveness Act of 1993 by Representative Walker. It contains 19 provisions which are dead-right-on for raising the tide for all companies in the United States.

America's companies have the guts, brains, and stamina to beat our foreign competition. What we need is a Washington with the courage to get out of the way and let us fight it out.

Thank you very much.

[The prepared statement of Dr. Rodgers follows:]

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

SUBCOMMITTEE ON TECHNOLOGY, ENVIRONMENT
AND AVIATION

MARCH 25, 1993

"THE ROAD TO HIGH-PERFORMANCE COMPUTING: FREE MARKETS OR GOVERNMENT SUBSIDIES? AN ENTREPRENEUR ENDORSES THE INVISIBLE HAND"

STATEMENT OF DR. T.J. RODGERS
PRESIDENT AND CEO
CYPRESS SEMICONDUCTOR CORPORATION
SAN JOSE, CA

Thank you for the opportunity to appear before the Subcommittee on Technology, Environment, and Aviation. I am here at the invitation of Representative Walker and the minority. Two years ago, I appeared before the Subcommittee on Technology and Competitiveness at the invitation of Representative Valentine and the majority. I appreciate the bipartisan interest in free-market technology development.

In my right hand I have a data-communications chip made by Cypress Semiconductor. We call it Hot-Link. It is capable of transporting information over a wire, or through an optical fiber, at the rate of 330 million bits per second. In my left hand I have a 4,196-bit static random-access memory (SRAM) chip also made by Cypress. It is capable of storing and retrieving data in three nanoseconds--about the time it takes light to travel one yard. It is the fastest SRAM available from any company in the world. Our Hot-Link chip would undoubtedly be part of any data communications network created in the United States--and in high volumes. Our super-fast SRAM is currently being used in conventional supercomputers.

I also have with me a Cypress module which contains two powerful SPARC processors of the kind that are used--500 modules at a time--in a massively parallel computer made by a company called Thinking Machines, in Cambridge, Massachusetts. Thinking Machines is a competitor of MasPar, one of the companies whose CEO, Jeff Kalb, is testifying here today.

In other words, Cypress makes data-communications chips used

in electronic superhighways, memory chips for supercomputers, and microprocessor modules for massively parallel computers. We would benefit greatly if billions of taxpayer dollars were showered on the various technology projects favored by the Clinton administration. It would be easy for me to support these projects. I could spend one minute talking about our products, a few more discussing the wonders of the basic technologies, a few more minutes on the serious peril we face from other countries, especially the government-financed Japanese and Europeans, and finally, I could ask for a dole--to save American high technology.

But I am here to say that such subsidies will hurt my company and our industry. Why? Because they represent tax-and-spend economics--a brand of economics that is a known failure. I do not want handouts. The men and women of our company do not want handouts. And if Congress wants to help American high technology, handouts are the wrong way to go--especially if they are funded with huge tax increases on individuals and corporations.

The subject of today's hearing is the High Performance Computing Act of 1991. But it is impossible to separate high-performance computing from the broader Clinton technology program. And it is impossible to separate the Clinton technology program from the administration's broader economic program. Thus, I will begin by presenting my views on the administration's general approach to economic and technology policy. I will then

address the particular issues surrounding high-performance computing. I will conclude with some concrete suggestions for enhancing America's technology leadership.

The Clinton Program: Three Misconceptions

Let me begin by correcting a serious (albeit politically useful) misconception. The administration would have us believe that the business leaders of Silicon Valley stand unanimously behind its program. The image of John Sculley, CEO of Apple Computer, sitting beside the First Lady and applauding the State of the Union address has been beamed far and wide by White House political operatives. John Sculley and I are friends and neighbors. We live in the same small town in the hills above Stanford University and Silicon Valley. But on this issue we are thousands of miles apart.

Indeed, I am here today in strong opposition to the administration's economic program in general and its technology agenda in particular. I am not alone. Over the last week, in preparation for this testimony, I corresponded with directors, founders, and CEOs of ten high-technology companies. Not one agreed with the proposition that the right way enhance America's technology leadership is to increase individual and corporate taxes to finance government mega-programs--even if the mega-programs support technologies being developed by those companies.

What follows are the ten opinions expressed to me over the past week:

o **Joe Kemke, CEO, Amdahl Corporation, America's largest manufacturer of IBM plug-compatible mainframes:** "Whether it is sugar subsidies or 'investments' in high-performance computing, the Clinton program represents the same logic: siphoning dollars from individuals and corporations and allocating them through a process that is terribly inefficient--a process that is responsive not to market requirements, but to bureaucratic empires and political payoffs. This use of tax money is disturbing at any time, but to increase expenditures as we face a historic deficit is unconscionable.

"As a high-technology executive who faces the rigors of the market every day, I view both the data highway and any subsidy of high-performance computers as the most recent examples of industries lining up to feed at the public trough. There may be a few select winners, but the majority, and the taxpayers, lose."

o **Don Valentine, venture capitalist, founding venture capitalist and director, Apple Computer, currently a director of five companies, including $600-million Cisco Systems:** "Don't assume that the Pepsi-Cola kid [John Sculley] speaks for Silicon Valley. We do not need pretenders who speak for us. We have visionaries who are rare, important, and doers.

"To Washington I say, please do not help us. The world of technology is complex, fast changing, unstructured, and thrives best when individuals are left alone to be different, creative, and disobedient. Go help the Russians. They are a Third-World technology state. Go help all the people who know how 'pork'

works, and who want to be taken care of. But please do not help us: Anyone who thinks corporate taxes promotes employment does not understand the problem."

o **Wilf Corrigan, CEO, LSI Logic, America's largest gate-array manufacturer:** "I am a strong supporter of industrial policy, but lowering taxes would be the best form of industrial policy we could have. We should balance the budget by cutting spending, and if that means we cannot put money into the high technology infrastructure, that is okay. If wealthy individuals get taxed more, they will spend more time figuring out how to minimize taxes and less time creating wealth."

o **Finis Conner, founder and CEO, Conner Periphsrals, Silicon Valley's leading disk-drive maker:** "President Clinton's proposed tax program will raise the U.S. corporate tax rate by 2 percent. We believe this strategy will accelerate the move of U.S. jobs offshore. There are plenty of countries that will welcome these jobs with open arms--and will offer tax incentives rather than tax increases. The development of all technologies and products involves risks and rewards. The government should not be in the business of speculating with taxpayers' money on which of those risks will be winners and which will be losers."

o **Gil Amelio, CEO, National Semiconductor, $1.6 billion chip company:** "Our current tax code encourages and instigates class warfare. Today, the top 5% of all wage earners pay 44% of all income tax--and if Mr. Clinton has his way this will increase further because he has campaigned on the basis of 'the politics

of envy'. He wants to punish with high taxes Americans who have been successful--that is, the people we need to revitalize our economy!"

o **Pierre Lamond, venture capitalist, founder, National Semiconductor:** "Every dollar that is taxed away from individual investment or corporate R&D will weaken America's high-technology companies."

o **L.J. Sevin, venture capitalist, former chairman, Convex, a supercomputer company, chairman, Cyrix, chip supplier:** "The companies that the administration claims got a 'free ride' generated all the jobs and foreign exchange. And the so-called free ride probably earned the government a factor-of-ten return on the investment. Somehow, the administration's attitude seems to be that any money the government does not take in taxes is a gift to corporations."

o **John Adler, CEO, Adaptec, a $300-million supplier of components and software to the personal-computer industry:** "I was delighted with President Clinton's initial two-for-one deficit-reduction target. I am now deeply concerned about the trend of moving away from significant deficit reduction to significant increases in government spending. I am not in favor of increased government spending--even if it is called investment, and even if it is directed to high technology."

o **Scott McNealy, CEO, Sun Microsystems, America's largest manufacturer of worketations:** "In the current economic climate, the proposed increase in the corporate tax rate does not

encourage job growth, business investment, or global competitiveness. Rather, it penalizes profits and will result in further loss of jobs."

o **Roger Emerick, CEO, Lam Research, a leading supplier of semiconductor-manufacturing equipment:** "Large investments in R&D and in building a world-class manufacturing capability have allowed Lam Research to gain global market share and create 350 new jobs over the past 12 months. Raising Lam's corporate taxes without strong additional R&D and investment incentives will reduce our ability to create jobs in the future."

These comments represent only some my recent communications with senior counterparts in Silicon Valley. So as we evaluate the President's program, let's be clear: Silicon Valley does not stand as a group in support of these tax-and-spend economic policies. Far from it.

There is a second dangerous misconception about the President's economic program. It too serves a useful political purpose. Indeed, it is a game as old as politics itself: divide-and-conquer, or, as Gil Amelio says, preaching the politics of envy. Yes, the White House tells the American people, we plan to increase spending by hundreds of billions of dollars. But we plan to spend that on "you." Even better, "they"--the bad guys--pay for it.

The bad guys, of course, are successful individuals and profitable corporations. Throughout the campaign last fall, and through the first two months of the administration, we have heard

endless talk about companies which, in the words of Labor Secretary Robert Reich, got a "free ride" in the 1980s. Or, as the President himself argued in the report that followed his State of the Union, the burden of the economic program will fall on "those who profited most from the uneven prosperity of the last decade."

Somehow, we never get to meet these bad guys. They are never in the room when tax increases are being discussed. Instead, political operatives offer caricatures--images of Michael Milken and Ivan Boesky defrauding investors of billions. Who would not want to tax such "excesses of the 1980s"?

So please allow me to re-introduce myself: I am an excess of the 1980s. Based on my ownership stake in Cypress, I am one of the people who, in the President's words, "profited most from the uneven prosperity of the last decade." I became a paper millionaire in the 1980s--eight times over, in fact.

How did I profit? I started a company in Silicon Valley. I obtained stock in that company when it had one employee (me) and one used computer. I worked with that company for a decade--sixteen hours a day, six days a week--to help get it where it is today.

And where is it? Over its ten-year history, Cypress has generated over $1 billion in cumulative revenue, made over $160 million in profits on which we paid $60 million in taxes, created 1,500 jobs and paid cumulative salaries of nearly $500 million, on which our employees paid taxes of $150 million. We have

shipped cumulative exports worth $300 million. We have generated a market value of $500 million for our shareholders and employees--all of whom own stock in the company.

If that is an "excess of the 1980s," let's have more! As an entrepreneur, I should not have to apologize for my success and that of my company. I am offended by the administration's divisive rhetoric. As we debate the virtues of raising taxes on individuals and corporations, let's not debate abstractions. Let's debate the realities of who pays and the impact of raising taxes on those people and companies.

I don't want sympathy. But I do want to expose the shaky foundations of the logic behind the administration's program. I am a person of simple tastes; therefore, I still have most of the wealth associated with my Cypress shares. What have I done with that wealth? I *invested* it. In fact, I invested it in precisely the kinds of companies on which the administration wants to shower taxpayer subsidies--the world's most advanced competitors in fields such as semiconductors, biotechnology, software, networking, environmental sciences, and health care.

Attached to my testimony is a list of more than 100 companies in which I hold investments through my participation in three venture-capital funds. Eighteen of those companies are innovators and leaders in high-speed data communications--*real* companies that are making *real* components of today's existing data superhighway. Other companies are innovators in the field of high-performance computing--including MasPar.

Every incremental dollar that Washington takes from me comes directly out of my investments in these companies. I cannot sell my house or car or cut my food bills. But I am going to invest less. After all, the cash to pay my higher taxes has to come from somewhere. Essentially, the administration is arguing that by taking my money in the form of higher taxes and "investing" it in subsidies, it can make better investments--create more jobs and wealth--than the venture-capital firms with which I invest--firms that are the envy of Japan and Europe. That logic defies common sense. Does anyone believe that Washington invests more effectively in high technology than the free market?

Last month, President Clinton and Vice President Gore visited Silicon Graphics, one of the great new-generation computer companies in Silicon Valley. By all accounts, they were amazed by what they saw. They declared their eagerness to help produce "more successes like Silicon Graphics."

I own shares in Silicon Graphics. It exists because hundreds of institutions and wealthy individuals like me--excesses of the 1980s--put their money into the company through venture capital. Washington cannot create more companies like Silicon Graphics. The way to create more Silicon Graphics is to allow knowledgeable investors, steering their money through world-class venture capitalists, to try to fund just the right companies with just the right technologies at just the right time. Even these venture experts are wrong more often than they are right. But surely they are right more often than Washington.

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The Clinton plan also raises taxes on Cypress as a corporation. Suppose, as a result of the plan, that Cypress's corporate taxes increase by $1 million next year. As CEO, my only choice is to take that money directly out of R&D--the lifeblood of the organization. Again, let's be clear about the logic: A tax increase of $1 million means that Cypress will employ ten fewer PhD technologists than it would otherwise--technologists that would be working on high-performance chips for data superhighways and supercomputers.

The third misconception about the Clinton plan brings us directly to high technology and high-performance computing. This misconception is ideological rather than political--but it is no less dangerous. It is the proposition that the best way for good ideas to become realities in the market is for government to subsidize them. There may well be, under certain limited circumstances, a legitimate place for government as a customer of last resort for high technology. But the administration wants to make government a customer of first resort--to the tune of tens of billions of dollars.

We have been down this road before. In the 1960s, we had a government that threw money at social problems. It didn't work. In the late 1980s, under President Bush, we had a government that threw money in many of the same directions as the Clinton program is now proposing. It didn't work; it brought us a meager one percent growth rate for four years. In the 1990s, we have a government that wants to throw even more money at such

opportunities. It won't work.

One More Time: The Case for Free Markets

What *does* work? The ragtag, unmanaged, sometimes-painful melee of the free market. It's not pretty, it's not neat, but it is what has made the United States the world's technology powerhouse.

Consider my personal investments. Via the Sequoia Fund, one of the venture-capital firms with which I deal, I am invested in Jeff Kalb's company, MasPar, a massively parallel computer manufacturer. On the other hand, venture capitalist John Doerr of Kleiner Perkins Caufield & Byers, another firm with which I invest, believes the entire supercomputing field is heading for a fall. His view: "The supercomputer industry is collapsing on itself. It is not a competitive way to solve problems. Why should we invest in dying markets?"

I hope that Sequoia is right and Kleiner Perkins is wrong. I hope Jeff Kalb succeeds with MasPar. But there is certainly plenty of risk in the investment equation. The best place to sort out that risk is the free market, with dynamic real-time decision-making--not with government programs that often take as long to implement as it takes for major technologies to run their lifecycle.

The administration is not alone in putting its faith in Washington over the free market. A few weeks ago, Massachusetts Representative Edward Markey, who chairs the Subcommittee on

Telecommunications and Finance, addressed an important computer-industry conference. First he complained that the industry did not lobby enough. I guess those computer executives were just spending too much time back home starting companies, creating products, entering new markets, making money. (Representative Markey's comment prompted me to dust off and modify a Vietnam-era phrase: What if they gave a subsidy and nobody came?)

Representative Markey went on to urge the executives to devote special attention to the data superhighway. His reasoning: "This is too important to be left to the invisible hand of the marketplace." I was amazed. That socio-economic experiment was tried once and failed--from 1917 to 1989. Which government-sponsored technology advances would Representative Markey like to compare to the embarrassment of riches generated by the "invisible hand"?

Today, in industry after industry--semiconductor chips, computers, biotechnology--U.S. companies lead the world or are mounting remarkable comebacks again Japan and Europe. Why are we moving forward against our foreign rivals? Because we relied on Darwinian competition--the invisible hand--while Japan and Europe relied on government targeting and subsidies.

Think about Japan. Just a few years ago, America was in panic about the Japanese government's massive research program in high-definition television, or HDTV. Today, everyone agrees that is was a multi-billion-dollar flop and that America has won--thanks to the messy, uncoordinated innovations of many private

companies. Five years ago, we lived in fear of the Japanese Fifth Generation Computer Project. "Tron" was going to walk, talk, and eat our lunch. Today, everyone agrees that it too was a flop and that U.S. computer manufacturers are extending their global lead.

Or think about Europe. Amazingly, we still have "experts" who want us to emulate Europe's alphabet soup of technology consortiums such as JESSI, its equivalent of the U.S. chip consortium Sematech. JESSI showered billions on the European semiconductor industry. It also "rationalized" the industry by allocating certain market segments to various companies. Siemens became the DRAM company for Europe--and has since gone out of the business. Philips became the SRAM company for Europe--and has since gone out of that business.

After inadvertently weakening its chip industry, Europe then established 14% import duties on foreign chips--the next logical step of desperate government policy. The import duty had precisely the effect we might expect: It raised the price of components to the European computer industry and virtually wiped it out as well. Today, there is no European chip industry or computer industry to speak of--thanks to the role of government programs like JESSI. European taxpayers gave up part of their income two wipe out to critical industries! We can't afford to emulate such failed experiments.

Industrial-policy advocates like to describe a few high-profile cases as success stories. Let's consider two of them.

The first is Airbus. It is true that European governments have unfairly subsidized their aircraft manufacturers and gained a large share of the world market. But at what cost? European governments have spent $26 *billion* on Airbus--to directly create 40,000 jobs. That works out to $650,000 per job. The National Venture Capital Association estimates that venture-funded startups generate employment at the rate of $45,800 per job. If Airbus represents industrial policy at its best, is it any wonder that Europe has experienced such chronic unemployment?

The second alleged "success story" is here at home. It has become fashionable to describe Sematech, the chip-industry manufacturing consortium, as a triumph of industrial policy. It is not. I have been called to Washington three times in the past few years to testify about the consortium and other proposals to prop up the U.S. chip establishment. Each time, I argued that most of the U.S. semiconductor industry was innovative and healthy--that Washington should not equate the struggles of a few giant companies in the mid-1980s with the fortunes of the entire industry.

What has happened? America again leads the world in semiconductors. In each of the last three years, the U.S. has won back market share from Japan. In 1992, our worldwide share actually exceeded Japan's share for the first time in a decade.

Sematech has waged a public-relations campaign to claim credit for the comeback. It is a preposterous claim. It is true that Washington spent $500 million of taxpayer money on the

Sematech boondoggle. It is true that the U.S. semiconductor industry has experienced a resurgence. It is not true that one had very much to do with the other.

The U.S. semiconductor industry resumed its leadership position because a new generation of chip companies forged in the 1980s--a generation of which Cypress is just one example--created innovative new categories of chips, new business models for how to compete, and new levels of efficiency. In short, we out-innovated the Japanese. America also resumed its leadership in great part because the giant companies of our industry--companies like Intel and Motorola--realized that they had to adapt or become also-rans. They adapted--and now lead the world.

Consider Intel. In the mid-1980s, Intel was losing money and in crisis. In 1992, Intel was the largest and most profitable chip company in the world. I am afraid to imagine what would happen if I cornered Intel's CEO, Andy Grove, at a cocktail party and said, "I am glad Sematech saved your company and turned Intel from a loser into a winner. I guess you ought to thank Uncle Sam." Of course, it was Intel's remarkable innovations in microprocessor architectures, along with top management's refusal to accept also-ran status and lots of hard work by thousands of men and women, that allowed it to recapture its lead.

Sematech has made little contribution to America's comeback in chips--certainly no contribution worth $500 million of taxpayer money. Indeed, sometimes this money was downright

counterproductive. In the 1980s and early 1990s, Sematech spent taxpayer dollars to develop equipment for the exclusive use of its members. Thus, taxpayer money, earmarked to help the U.S. semiconductor industry, was being used to hurt the 90% of American chip companies that were not members of Sematech--to hurt the very industry it was meant to help.

William Spencer, the new president of Sematech, has cleaned up the worst abuses. But Sematech's return on the taxpayer dollar is still not evident. Five years ago, when it was created, Sematech's membership included only 14 giants out of the hundreds of America semiconductor companies. In the last year, two of the member companies (the two most entrepreneurial companies, LSI Logic and Micron Technology) left the consortium. Two more companies are reported to be considering departures. The simple lesson: Relentless competition and fast-paced innovation saved the U.S. chip industry--not taxpayer subsidies.

Surely this is no surprise. Life in Silicon Valley is a daily sprint; government moves at a crawl. Does any of us really believe that Washington can play a decisively helpful role in fields as complex as semiconductors, high-performance computers, or electronic data superhighways?

Think for a moment about the realities of life at Cypress and then extrapolate it to the chip industry and Silicon Valley as a whole. Our company has 150 product designers. We have one hundred PhD technologists. We sell more than 1500 products. We are working right now on 50 different new products--from high-

speed computer memories to data communications chips. With my technical training and my managerial background, it takes me 16 hours a day to stay on top of this organization.

Cypress is one $250 million company. Semiconductors are a $50-billion industry. Thus, if you take the complexity I just described and multiply it by 200, you have a sense of the complexity of the chip industry. If you take that level of complexity and multiply it by another factor of ten or more, you have the complexity of Silicon Valley. How can the government possibly hope to cope with the details of Silicon Valley? How could the government even know who the players were in any week, let alone pick winners and losers?

Now think for a moment about something less complex: the *tobacco leaf*. Today, the U.S. government spends tens of millions of dollars through the Office of the Surgeon General to warn Americans about the dangers of smoking. At the same time, through loan guarantees and occasional direct grants from the Department of Agriculture, it has spent tens of millions of dollars to subsidize tobacco farmers.

If government cannot figure out whether to discourage smoking or to subsidize it--and if it spends taxpayer money to do both--how can it think straight about technology choices in fields as complex as optical fibers, wireless data communications, or high-performance computers? If, after several decades, it cannot make a winner/loser decision on the tobacco leaf, how can it make it winner/loser decisions in Silicon

Valley, where the game changes weekly?

Tax-and-Spend--But With a High-Tech Twist

How, then, do I evaluate the administration's multi-billion-dollar technology plan? Put simply, it is classic failed tax-and-spend economics with a new coat of paint and new jargon. Bridge-and-tunnel pork-barrel programs may have been replaced by high-technology pork-barrel programs--but it is pork-barrel just the same.

I want to be fair. The administration is beginning to move the government towards a high-technology vision, a development that I view as favorable. I certainly share its enthusiasm for an America in which computers and communications carry data and video into companies and schools, and eventually into the home. But why does the administration want to spend tens of billions of dollars of taxpayer money to fund technology programs that the free market will pay for without one cent of expense to the taxpayer?

For example, the administration proposes big spending increases on a range of projects to speed creation of the "data superhighway." The technology plan outlined by President Clinton last month offers few substantive details about these projects. But the details it does offer make one point clear: Everything in the program is already being funded by venture capitalists and being developed by innovative private companies, many of which I personally support.

Multiple, competing data highways are being built day-by-day, company-by-company, across the United States. Entrepreneurs are racing to develop new networking systems, new software interfaces, new value-added services. Gil Amelio, whose comments I cited earlier, was a senior executive at Rockwell before he joined National Semiconductor. Gil reports that his division at Rockwell created the hardware to lay 23 million miles of fiber-optic cable!

MCI, AT&T and Sprint already have three independent, coast-to-coast, fiber-based long-haul networks. The real issue is extending those networks into the home. There is a role for government in this, but it is not to spend billions of taxpayer dollars on a field that the private sector is willing to fund. The role for government is to untangle the morass of bureaucracy and regulations that prevents private companies from hooking up the "last mile" of fiber to the home. For example:

o The regional Bell operating companies would gladly hook fiber optics from the long-haul network to the home. But they are prevented from doing so by regulations that make the huge capital investments uneconomical.

o Cable operators are already hooked into 60% of American homes. They too could make the connection with existing long-haul data superhighways, but they are prevented by regulations that declare them a "natural monopoly" and restrict them to television and movie business.

o Finally, the long-haul superhighway could be hooked to

the home through wireless circuits. But the frequencies required are currently being held up by the Federal Communications Commission.

Washington does not need to "help" by spending billions of dollars on data superhighways. These highways will reach the home for free if government becomes *less unhelpful--if its gets its regulatory house in order and then gets out of the way.* Even the Berkeley Roundtable on the International Economy (BRIE), the liberal think tank that contributed Laura Tyson to head the President's Council of Economic Advisors, agrees that one centralized data superhighway--in its words, "the all-singing, all-dancing, all-integrated broadband network"--is not how computers and communications will come to the home. What we need from Washington are common-sense rules and a sense of the limits of government activism.

The same logic applies to high-performance computing. The prevailing image of supercomputing in Washington remains tied to the Cold War: giant machines, funded by the Defense Establishment, being used to design nuclear warheads or track thousands of incoming missiles. But the Cold War is over. And we may be at the beginning of the end of the era of high-performance computing, at least as it has been conventionally defined. We have seen the limits of gigantic "number crunchers" of the kind developed by Seymour Cray. We are seeing the arrival of smaller machines, massively parallel machines, machines with new architectures designed for ease of software development

rather than raw number-crunching capability.

In short, the high-performance computing industry is entering a period of profound change. This is precisely the time when venture capitalists are most effective at setting new directions and funding new players. Heavy-handed intervention from Washington is guaranteed to retard change rather than to encourage it. Venture capitalist L.J. Sevin, the former chairman of supercomputer-maker Convex, puts it this way: "The supercomputer market is changing dramatically because the nature of the technology is changing. The only thing government can do is get in the way of that change--with disastrous results."

A Proposal from the Past: A Rising Tide Lifts All Boats

So much for what not to do. Let me offer constructive alternatives. Please forgive me for not having a convenient, five-point program to enhance America's economic leadership. In fact, I don't believe in such programs, because I understand first-hand the messiness, unpredictability, and rapid changes in high-technology markets. As illustrated here, well-intentioned industrial policies usually create damage, even though their architects want to help.

Washington should stay away from the intricacies of high-tech competition--whether the issue is the data superhighway, high-performance computing, or advanced manufacturing. It should focus instead on the *infrastructure* of competition--those factors of production that help all companies equally. President Kennedy

said it best: "A rising tide lifts all boats."

Members of the Clinton administration love to give speeches about infrastructure: deteriorating roads, falling bridges, aging railroads, even data superhighways. But the real threat to our country's economic future is the condition of our *financial* infrastructure--the scarce supply of reasonably priced capital that successful companies need to build their manufacturing muscle. If Washington adopted policies designed to lower (and keep low) the cost of capital and extend the time horizons of investors, it would make a genuine contribution to America's entrepreneurial advances in the 1990s.

Washington can take two steps to restore our financial infrastructure. After years of the most reckless fiscal behavior in American history, it must get serious about reducing wasteful spending. And it must get serious in a hurry.

The Clinton administration has boasted about its proposed spending cuts and its reduction in the White House staff. But it has not begun to approach the dramatic cuts we need. You can pick up any newspaper any day of the week and read about the painful efforts of giant companies--General Motors, IBM, Sears--to slash their costs, streamline their overhead, reduce their payrolls. Boeing recently announced plans to dismiss 20 percent of its workers--and Boeing is a world-class company by any standard. My company, in a decision of great personal pain to me, recently dismissed 20% of our workers to become more efficient--and we started out as one of the leanest and most

efficient chip companies in the United States.

How then, in light of these sacrifices, can the administration trumpet its plans to eliminate 100,000 federal jobs over the next four years--only 5 percent of a total workforce of two million? Does the administration expect us to believe that if a company as great as Boeing can figure out how to survive with 20% fewer people, the Department of Agriculture cannot live with an immediate reduction in headcount of 25%? Does he expect us to believe that the Department of Transportation needs fewer efficiency-improvements than Cypress?

The opportunities for cuts go beyond headcount. We could spend hours listing wasteful and unnecessary programs--programs that may have made sense 30 or 40 years ago, when they were created, but that make no sense today. We could begin with two of my personal favorites: the federal wool-uniform subsidy, created during World War II and later expanded to include mohair sheep (for no reason other than pork-barrel); and the Interior Department's strategic helium reserve (created during World War I), which is keeping America well-stocked, at $120 million per year, for the next blimp war. Why are we asking for more money from America's hard-pressed people and companies when follies like this exist?

I believe there is only one way to impose real spending discipline: Congress must pass a balanced-budget amendment and approve the line-item veto. Let me restate the point: No industrial policy or national investment strategy or trade

negotiation, no matter how brilliant, would have the same energizing effect on American entrepreneurship as a return to fiscal sanity through dramatic spending reductions. It is a prerequisite to economic leadership.

Washington should take a second important step. It should restructure the capital gains tax to punish short-term speculation and encourage long-term investment. The Clinton administration has proposed a modest reduction in the capital-gains tax targeted to tiny companies. The proposal is good political symbolism, but it does not address the real problems of real entrepreneurs.

We already have plenty of venture capital funding for start-up companies. No good engineer in Silicon Valley will be refused his or her first $10 million to prove the feasibility of a new technology or product. The problems start at the next stage, when a company needs its second or third $10 million to build a plant and acquire real manufacturing muscle. This stage is when young companies must turn to the public capital markets--or to cash-rich foreign operations eager to acquire valuable American technology at bargain-basement prices. It is here that they face the most serious barriers. The best way to reduce the barriers is to enact a sweeping restructuring of the capital-gains tax.

Unfortunately, a majority of Americans have been convinced that any reduction in capital gains is a "tax break for the rich." That's why we should *increase* taxes on assets held for less than six months by imposing a surcharge over the nominal

capital gains rate. This surcharge would be a stiff disincentive to unproductive speculation. It would allow us to argue, rightly, that we plan to "soak the rich"--or at least the rich who play hunches, trade on rumors, and churn investments to the detriment of the American economy. In return for this penalty on speculation, capital-gains taxes on assets held for more than three years, assets that help build America, would be totally eliminated. Assets held between six months and three years would be taxed at the current income tax rate.

So there you have it. A program for American renewal that revolves around immediate and dramatic cuts in government spending, a balanced-budget amendment, and a restructuring of the capital gains tax. Hardly the stuff of brass bands and whistle-stop tours, especially with all the energetic talk these days of critical technologies, high-speed data communications, and high-performance supercomputing.

I wish I could propose a razzle-dazzle plan, complete with spectacular computer graphics, to capture the imagination of Washington and put America back on track. But those of us who are out competing every day understand that there are real limits to Washington's potential contributions to our success--and countless opportunities for mischief and missteps.

America has plenty of work to do on the economic problems we have created for ourselves--problems that trace their roots to fiscal recklessness. Ultimately, though, the economic battles of the 1990s will be won in America's factories, labs, and offices--

not in the halls of Congress or the corridors of the White House. That's good news. America's entrepreneurial companies have the guts, brains, and drive to beat the best the world has to offer. All we need from Washington is the confidence to let us fight it out.

APPENDIX

What follows is a list of companies funded by three venture-capital partnerships in which I participate as an investor. Companies in boldface are directly involved in high-speed data communications and high-performance computing.

Kleiner Perkins Caufield & Byers Zaibatsu Fund I

3DO
(Interactive multimedia)
Aptix
(Field-programmable printed circuit boards)
Arris Pharmaceuticals
(Drug development)
Ascend Communications
(Communication products for digital networks)
Axion Pharmaceuticals
(Drug development)
Biosite
(Immunodiagnostics)
Cellular Data
(Cellular phone network equipment)
Citrix Systems
(LAN system software)
Coactive Computing
(Networking hardware and software)
Conductus
(Superconductors)
Domestic Automation
(Networking systems)
EO Computer
(Mobile Computing)
Evernet Systems
(Networking systems)
Genetrix
(Genetic testing lab)
GenPharm International
(Transgenic animal technology)
GO Corporation
(Pen-based computing)
Harmonic Lightwaves
(Optical communications)
Insite Vision
(Opthalmic drugs)
Intuit
(Financial software)
Kera Vision
(Device to correct eye problems)
Ligand Pharmaceuticals
(Drug development)

Macromedia
(Multimedia authoring software)
MasPar Computer
(Massively parallel computers)
Ministor Peripherals
(Disk drives for portable computers)
nChip
(Silicon circuit board packages)
Notable Technologies
(Communications software)
ON Technology
(Collaborative software)
Oxford Glycosystems
(Drug development)
Pharmalytics
(Drug development)
Power Integrations
(Integrated circuits)
Quickturn
(Protyping machines for ASIC market)
Rambus
(High-bandwidth bus)
Raster Graphics
(Color plotters)
Ribogene
(Drug development)
Rose Communications
(Wireless key telephone systems)
S3
(Silicon accelerators for Windows)
Shiva
(Internetworking products)
Slate
(Software for pen computers)
Tivoli Systems
(Software)

Sequoia Partners Fund III

Alantec
(Networking concentrators)
Applied Micro Circuits
(High-speed custom chips)
Ask Computer
(Relational database management)
Avid Technology
(Digital editing systems)
Banyan
(Network servers)
Business Insurance
(Workers compensation company)

C-Cube Microsystems
(Integrated circuits)
Cadence
(Electronic CAD and CAE)
Camino Labs
(Pressure monitoring systems)
Central Point Software
(Personal-computer software)
Chemtrak
(Patient-side diagnostic systems)
Communications Ventures
(Investments in later-stage telecomm companies)
Covalent Systems
(System software and data collections)
Cypress Semiconductor
(CMOS integrated circuits)
Datalogix
(Planning software for process manufacturers)
D.S.L.-David Systems
(LAN networking)
Endosonics
(Minimally invasive surgery)
Farallon
(Data communications equipment)
Great Lakes Environmental
(Disposal of hazardous waste)
In-Site Vision
(Drug delivery to the eyes)
IST
(Specialized maintenance and fab services)
Logic Modeling
(Software/hardware products)
Magellan
(Navigation products)
Progress Software
(Relational databases)
Quickturn
(Computer-aided prototyping)
Radius
(High-performance graphics peripherals)
Relevant Technologies
(Turnkey, contract manufacturing services)
Sierra Semiconductor
(ASIC circuits)
Total Pharmaceutical
(Products and services for home patients and nursing homes)
Vitesse
(LSI digital gallium-arsenide circuits)

Sequoia Partners Fund V
Amylin Pharmaceuticals
(Novel therapeutic drug products)

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Mr. KLEIN. [presiding] I believe we have one more witness, Mr. Kalb.

Mr. KALB. Yes, thank you. Mr. Chairman and members of this distinguished subcommittee, I'm Jeff Kalb, the president and CEO of MasPar Computer Corporation. We're a manufacturer of massively parallel computers located in Sunnyvale, California.

On behalf of the American Electronics Association, which I am representing, my company, and myself, I wish to thank you for this opportunity and to convey strong support for the HPCC and to commend all the parties who have contributed to the progress that has been made to date.

High performance computing will be one of the most important forces in shaping both the computer industry and the national competitiveness in the decades ahead. But today I'd like to give you a slightly different perspective than what you may have heard before.

The driving force in the computer industry for the last 15 years has been the microprocessor. In its first instantiation, it gave birth to the personal computer, the PC. And in doing so, it made possible computers at a lower price than ever existed before, and created a $100 billion business in products and services that was essentially incremental to pre-existing industry. The reason was not only that it was a new product category, but that it changed the way people worked, and it changed the way they solved problems. It's given us spreadsheets, desktop publishing, new communications vehicles, and many other facilities that we never had before.

Now microprocessors are giving us massively parallel computers. Only this time we're building systems that go into a performance range where they've never been before. And this can have the same kind of impact as the PC, creating businesses and improving capabilities which are largely incremental to the pre-existing situation.

As with the PC revolution, I expect to see unforeseen new products, new services, and a greater competitiveness that goes well beyond the computer industry and into the economy as a whole. The federal government has had a significant role in creation of the massively parallel industry. When it started, the vision was that of a replacement for supercomputers, which in themselves had made significant and substantial contributions to the industry. In more recent years, the concept of the grand challenges have provided a focal point for discussing and acting on the high performance computing needs. But the potential goes well beyond this.

Today we have a different situation than existed only a few years ago. Disarmament poses new challenges in information gathering and analysis. For instance, Raytheon is deploying massively parallel computers in the next-generation, over-the-horizon radar systems. Industry has complex problems, from scheduling distribution systems to improving the efficiency of automobiles. And competition demands that we gain every possible edge. For instance, Motorola has publicly stated that they need to reduce the design cycle time on their new products by 90 percent, and that they need massively parallel computers to do that. And, as all of you know, we're swamped with mountains of data, whether it be from satellites, business sources, or whatever, and we don't have the computing power or the time to analyze it.

Massively parallel computing promises the ability to solve many of these problems. And while we might compare massively parallel systems to the PCs in terms of the impact that they can have, the problems which must be solved before we can have this happen are fundamentally different.

When PCs came out, there was an enormous infrastructure of trained people and pre-existing applications. Massively parallel processors are different. They require new or enhanced programming skills, and most of today's systems are too expensive to be deployed broadly. These are areas where the federal government can help. Actions can be taken in training; laying out a road map of needs and technologies, as the semiconductor industry has done so effectively; and encouraging low-cost, reliable systems so they can be deployed broadly.

And there's an opportunity to kill two birds with one stone. Couple part of this effort with a retraining of the military and the aerospace workers. The situation is similar to that that we had at the end of World War II. Then, we trained a whole generation of warriors with the skills necessary to build a peace unsurpassed in history. Now, we have a generation of cold warriors who have served their country well. We could focus this new training around challenging these people to enter that field; seed them into companies pursuing the use of massively parallel computers; and use American ingenuity to create new and better products and services.

To make this reality, we need to adopt a slightly different vision than the one which has prevailed. We need to focus more of our resources toward software, and enabling the benefits to be realized across a much broader base of people and applications. And we need improved government and industry collaboration. If that's accomplished, we will not only accelerate the growth of this important industry and improve the competitiveness of the country, but will compete the visionary promise of the efforts which the federal government has made for the last decade. The correct focus here can pay immeasurable dividends.

Thank you very much.

[The prepared statement of Mr. Kalb follows:]

AMERICAN ELECTRONICS ASSOCIATION

TESTIMONY OF
MR. JEFFREY C. KALB,
PRESIDENT AND CEO
MASPAR COMPUTER CORPORATION

ON BEHALF OF
THE AMERICAN ELECTRONICS ASSOCIATION

BEFORE THE SUBCOMMITTEE ON
TECHNOLOGY, ENVIRONMENT AND AVIATION
OF THE
HOUSE COMMITTEE ON SCIENCE, SPACE AND
TECHNOLOGY

MARCH 25, 1993

American Electronics Association

1225 Eye Street N.W. Suite 950 Washington D.C. 20005 Telephone (202) 682 9110 Fax (202) 682 9111
5201 Great America Pkwy P.O. Box 54990 Santa Clara CA 95056 Telephone (408) 987 4200 Fax (408) 970 8565

Mr. Chairman and members of this distinguished Subcommittee, my name is Jeff Kalb. I am the President and Chief Executive Officer of MasPar Computer Corporation, a developer of massively parallel computer systems, based in Sunnyvale, California. I appear before you today as a representative of the American Electronics Association (AEA).

About the American Electronics Association

The AEA is the nation's largest electronics trade association, representing over 2,700 companies in the electronics and information technology industry. The voice of the industry for over 50 years, AEA has an active grassroots network of 17 councils in all key U.S. high-technology centers, as well as offices in Tokyo and Brussels. AEA member companies are all based in the U.S. and span the breadth of the electronics industry, from silicon to software to all levels of computers and systems integration. The giants of the electronics industry are AEA members. At the same time, almost 70 percent of AEA members are small-to-medium-sized entrepreneurs with less than 250 employees and less than $50 million in annual sales. The AEA also has recruited 60 of the nations top engineering research universities as associate members to foster closer working relationships between industry and academia.

In addition, the AEA also sponsors two broad-based coalitions, the High-Performance Computing and Communications Consortium and the Advanced Technology Coalition, which enables numerous industry sectors, labor, academia, and professional societies to work together to advance the HPCC initiative and critical technology and manufacturing programs.

Introduction

Mr. Chairman, I very much appreciate the opportunity to contribute to your hearings on a National Technology Policy and the High-Performance Computing and Communications (HPCC) Act of 1991. The House Science, Space and Technology Committee is to be commended for the leadership role it has played in advancing American leadership in high-performance computing and communications to date, and for its foresight in considering new initiatives to further advance the nation. The AEA very much supports the near-term action of Congress on these issues vital to American leadership in a wide range of technologies.

The AEA shares the opinion of the Clinton Administration, the Congress, and many others that our nation is at an important industrial crossroads. Without visionary technology policy and significant financial investments, the U.S. is at risk of losing its leadership in many scientific and industrial arenas. As we move into the 21st century, we will experience ever-increasing global competition across our existing industry sectors, and advances in technology will yield completely new products and services designed for the world market. Product life-cycles will be shortened, and

the time required to win or lose in major markets will be accelerated. Within that setting, those nations with the best technology infrastructures will dominate emerging markets. Once an advantage is established, it will require investment to recapture the lead. By investing today in America's technology infrastructure, we will lay the foundation for the high value-added, high wage jobs we must have if we are to maintain our standard of living. The AEA is eager to work with the Congress and the Administration to develop a policy and program that will ensure American industrial leadership in the '90s and in the 21st Century.

In addition, AEA will continue to sponsor the High-Performance Computing and Communications Consortium to facilitate broad-based private sector consensus on HPCC issues. The Consortium comprises over 75 representatives of a variety of industry segments and academia who are involved or interested in high-performance computing and communications. The Consortium's mission is to ensure that a broad range of industry executives and members of academia all have substantive input in the development and implementation of HPCC policies and programs. By drawing on the expertise of hardware manufacturers, software developers, service suppliers, and academic and research institutions, the Consortium offers balanced input to policy makers from a representative group of HPCC constituents.

There is strong consensus among Consortium members that effective implementation of the High-Performance Computing and Communications Initiative requires:

- o Increased private sector input in HPCC Initiative planning, policy setting, and program evaluation.
- o Increased federal agency coordination and centralized management of the Initiative.
- o Full, annual funding through FY 1996 for the HPCC Initiative -- including defined HPCC programs in eight federal agencies.

The Consortium will provide the Committee with detailed recommendations on these and other HPCC Initiative implementation issues, and looks forward to working with Congress and the Administration to develop consensus on the future directions of the Initiative. Consortium members view the HPCC Initiative as a significant cornerstone for the "National Information Infrastructure," and as such it is critical that we pull together all of the key participants to help chart its course for the future.

I. ASSESSMENT OF THE HIGH-PERFORMANCE COMPUTING AND COMMUNICATIONS INITIATIVE

The AEA strongly supports the High-performance Computing and Communications Act of 1991. It has already made a significant contribution to American leadership in

advanced computing and communications, and it will provide a strong foundation for the upcoming National Information Infrastructure Initiative. We believe the HPCC Initiative should be fully funded and, with an expanded charter, we would support significantly expanding the program funding.

The High-Performance Computing Act has already made several key contributions:

- o Establishment of a national goal and improved program and policy coordination between federal agencies involved in high-performance computing and communications.
- o Acceleration of the development of HPCC technologies, especially massively parallel systems and software required to solve the most compute-intensive problems.
- o Advancement of America's high-performance computing and communications infrastructure.
- o Improved collaboration between government, academia, and industry on formulating U.S. technology policy.

These are important achievements that will provide the foundation for our HPCC and National Information Infrastructure Initiatives. However, we believe there is significant opportunity to dramatically improve the contribution of the HPCC Initiative through additional focus in the following five areas:

1. HPCC for U.S. industrial global competitiveness.
2. Greater investments in the education of applications development engineers.
3. Further incentives for the creation of new technology businesses.
4. Specific goals, objectives, measures, and ongoing management of HPCC programs.
5. Increased collaboration between industry, academia, and government.

1. HPCC for U.S. Industrial Global Competitiveness

We believe there is a broader opportunity emerging for high-performance computing and communications than is currently being effectively addressed by the HPCC program. Specifically, we believe that advances in the cost-effectiveness of high-

performance computing and communications availed by the use of affordable high-performance computing technology can enable thousands if not millions of commercial customers to benefit from this technology in the coming years. If the proper investments in software and systems infrastructure are made by the government in the next few years, American industry will be able to successfully exploit affordable vector and massively parallel processor (MPP) technologies. These advances will enable companies to develop and bring to market products ranging from automobiles to pharmaceuticals to jet aircraft to semiconductors more quickly than our international competitors. This would result in sustainable advantages over our global competitors in many industries for many years to come. In the computer hardware, software, and services businesses alone, we believe a robust HPCC industry will cause significant job creation and greatly contribute to America's GDP. Additionally, the financial benefits and the job creation/retention delivered to other industrial segments has the potential to be much more significant. Industry can better exploit this opportunity if the Federal Government expands its support for research and development of pre-competitive HPCC technologies and applications.

Advances in Computer System Affordability Create Markets

Throughout the history of the computing industry, significant new markets have been enabled whenever there have been significant advances in the affordability of the technology. This was demonstrated in the 1950's through the 1970's through the impressive growth of both the mainframe and minicomputer businesses, and again in the 1980's with the phenomenal growth of the personal computer and engineering workstations/server markets. For example, between 1983 and 1991, the personal computer/workstation share of the overall worldwide computing market increased from 24 percent to 52 percent. Part of the reason for this growth is that customers will exploit new technologies that are affordable and can economically solve problems. While responsibility for developing competitive products rests largely with industry, government's has an essential role in fostering the development of affordable high-performance computing systems and ensuring opportunities for fair competition both here and abroad. A competitive marketplace provides the best incentive for industry to invest in and exploit these opportunities. We need government's support to help ensure that the U.S. does not lose a major emerging market segment to our international competitors. Already governments such as India, Japan, Italy, and South Korea are initiating MPP development programs.

The AEA believes that we should continue to push the "Grand Chailenges" of science, but we should now expand our focus to include the "Grand Challenges of American Industry" by fostering the development of high-performance computing and communications technology affordable enough for broad commercial use. While today's supercomputer technology has enabled significant breakthroughs in science and industry, it represents less than 2 percent of the total world market for computers. We believe that the development of affordable high-performance

computing and communications technology will help the industry grow and create jobs, while assisting a much broader range of end-use customers.

HPCC Technology for Economic Leadership

Computer industry growth is but one part of the potential impact of affordable high-performance computing and communications. The real impact accrues to the new users who can develop better products and services by solving problems previously beyond their means.

A very good example of the need for affordable high-performance computing is provided by MasPar's experience with Motorola. They believe that in order to be globally competitive in the year 2000, they must reduce product development cycle times by 90 percent. In order to achieve this objective, company executives believe they will need to use massively parallel computers to simulate the entire product, from semiconductor device simulation to product packaging to the manufacturing process. This would eliminate the traditional prototyping process, and result in finished products ready for customer consumption the first time out.

While the actual investment in information processing technology may be higher than that of today, Motorola believes tremendous competitive advantage can be achieved by distributing high-performance computing broadly within the user community. This vision can only be achieved through very affordable MPP systems and advanced networking technologies which can support electrical, mechanical, and manufacturing process engineers.

HPCC Technology for Dual-Use

An example of the maturation of MPP technology is provided by Raytheon's use of technology developed by my own company for their new Ground-Based Radar System. Instead of developing proprietary military specification hardware for the system, Raytheon will be using Commercial-Off-The-Shelf (COTS) MPP technology on a globally deployed system. The net effect of this decision will be to reduce the lifecycle cost of the computational engine and software of the Radar system by as much as 90 percent. And this is only one example of a company exploiting MPP technology for competitive advantage and cost effectiveness. Cray Research has for many years provided systems for both military and commercial applications. Prudential-Bache has purchased an Intel MPP system for securities analysis, while American Express has purchased a Thinking Machines system, and Kendall Square Research has just announced a collaboration with American Airlines/EDS. The limiting factor to the growth of this market is the lack of widespread availability of applications and trained resources.

2. Greater Investments in the Education of Software Development Engineers

The key to developing this major new computer systems market and to advancing a wide range of industrial sectors is the development of a new generation of computer programmers that can write software for a variety of high-performance computers. While the current Congressional discussions on building upon the High-Performance Computing Act through an increased focus on applications is correct, the training of the software development engineers that will produce these applications is a fundamental step. The availability of tens-of-thousands of well-trained software development engineers with the capability of programming parallel high-performance computers will provide the cornerstone for any follow-on HPCC or National Information Infrastructure Initiatives.

The National Science Foundation should re-double its efforts to provide universities with wide spread access to what the users judge to be the most promising high-performance computers available at any given time. Additional resources should be made available to universities through NSF for updating undergraduate and graduate curricula to ensure that new computer scientists and engineers are capable of programming parallel high-performance computers. Full funding for the Foundation's HPCC program continues to be particularly critical because of its unique role as the integrator between the best capabilities available and many innovative scientists and engineers in the research and industrial communities. In many respects, the NSF, with its focus on the development of "human capital", should be viewed as the driving force behind the HPCC Initiative. The U.S. should be the dominant supplier of highly-skilled parallel programmers. Such a lead in "human capital" will create a tremendous range of new information processing solutions that will advance many different industries faster than our global competitors.

The AEA also believes that many defense engineers and scientists who are currently being displaced as a result of the declining defense budget would make excellent software development engineers and managers. However, retraining is fundamental to transitioning these workers into this emerging industry. We would encourage efforts to assist these workers in transition to this and other emerging technology businesses in the coming months and years, rather than training them for "existing" careers for which there are already too many applicants.

3. Further Incentives for the Creation of New Technology Businesses

In order to create the wide range of solutions required by science and industry, we need to foster technological innovation and the creation of many new hardware, software, networking, and consulting businesses. To accomplish that, the AEA strongly supports the proposals outlined by President Clinton and Vice President Gore to encourage job creation and industry expansion. Critical elements include: an

expanded SBIR program; permanent provision for the Research and Experimentation Tax Credit; reduced taxation on long-term investments; government support for patient capital; and simplification of the regulatory process for new technology businesses.

As outlined above, displaced defense workers may also provide many of the entrepreneurs of tomorrow. With the expertise many of these technical personnel have developed winning the Cold War, they have the potential to produce many extraordinary new products for the civilian marketplace. After World War II, the education and training provided to returning military personnel provided the foundation and stimulus for decades of economic growth. Doing similar things for our "Cold Warriors" could have the same impact. We would encourage federal government initiatives to help such workers start new businesses – a potential major source of our nation's technology and employment growth in the coming years.

4. Specific Goals, Objectives, Measures, and Ongoing Management of HPCC Programs

The AEA believes the objectives of the HPCC Act can be better supported through more specific goal setting, measures, and management of the Initiative. With a greater focus on translating leadership in high-performance computing and communications into competitive advantages for American industry, we believe all involved will maximize the benefits of the Initiative.

Recommendations:

- The AEA commends the creation of the HPCC Coordination Office, which provides a much-need coordination mechanism and focal point for private sector inquiries. However, the Office lacks the resources and authority to provide the management and oversight needed to ensure a successful HPCC Initiative. We recommend that the Subcommittee consider chartering an entity with the authority to provide such leadership for the Initiative, as well as to drive the accountability of the various programs, and foster private sector partnerships in the pursuit of HPCC goals.

- There should be more detailed annual plans which go beyond the HPCC "Blue Book" in outlining the annual agenda for the various players within the program. Each group's accomplishments versus plan should be assessed annually, with more resources accruing to those who deliver the most substantial results. We believe that particular weight should be given to those who are leveraging the technology into near-term industrial leadership, through test beds, proof of concept applications development, and the training of skilled personnel.

Examples of such metrics include.

- Number of application test beds targeted by given dates.
- Number of software development engineers trained by given dates.
- Number of new start-up companies initiated due to HPCC Programs.
- Specific results achieved through investments in hardware, software, and other HPCC technologies.

5. More Collaboration Between Government, Industry, and Academia

An important, but ignored, aspect of the High-Performance Computing Act of 1991 is the required Presidential establishment of The High-Performance Computing Advisory Committee. The AEA believes that such an advisory body, made up of non-Federal participants in the HPCC Initiative is fundamental to ensuring a high level of collaboration between government, industry, and academia. We believe the Committee's absence has impeded the progress of the HPCC Initiative and it should be established as soon as possible.

Recommendations:

- o Work with the Office of Science and Technology Policy to immediately establish the High-Performance Computing Advisory Committee.

- o Establish an annual conference of government, industry, and academia to review the previous year's results achieved versus objectives, and to establish joint objectives for the coming year. This would help ensure maximum collaboration between all parties empowered to advance the Initiative.

- o Create an adequately staffed HPCC information clearing house for information dissemination and collaboration.

II. HPCC APPLICATIONS AND THE NATIONAL INFORMATION INFRASTRUCTURE

The AEA is eager to work with Congress on the Information Infrastructure and Technology Act of 1992 (Title VI of S.4) which would advance research in the application arenas of education, manufacturing, health care, and libraries, and contribute to the development of the "Information Superhighways" for the 21st century. We believe this represents an important step in the evolution of the HPCC Initiative toward solving the computational and communications problems of a broad range of Americans. We believe the greater the focus on "real" problem solving, the

greater the national benefits that will accrue from our leadership in high-performance computing and communications. The goal should be to stimulate the development of all promising technologies and let market forces determine which ones succeed.

In addition to HPCC, a new market is emerging for mobile and wireless computing in which hand-held information servers will enable anytime-anywhere-access to, and interaction with, needed information sources. This market attacks the issue of personal productivity by breaking down barriers to retrieving and manipulating data and information more efficiently than existing systems. Such personal information servers will network to massively parallel computers, which will archive information in large data types which, in turn, enhance user interfaces and the display of information. The technological basis of these capabilities should be an important component of research programs in NIST and NSF.

Relative to the Information Infrastructure Initiative, if the U.S. is to maintain or advance its leadership in science, technology, or education, we must make this investment. By combining the forces of industry, government, and academia, the AEA believes we can aggressively move forward with the development of our "Information Superhighways." This effort will clearly be one of the most important technological undertakings the U.S. has ever pursued. When implemented, a national information superhighway will dramatically change the way we conduct basic research, design and produce consumer products, and conduct life-long learning to name just a few contributions. The complete benefits to the Nation are impossible to accurately measure today. But there is little question that our leadership in almost all disciplines will be advanced by a National Information Infrastructure Initiative.

Today information technology plays a critical role in almost every industry and service business. The leading companies in business including clothing manufacturing, banking, pharmaceuticals, airlines, retail, and automobiles owe a significant part of their success to their innovative use of information technology (see Addendum #1). With the advent of electronic superhighways, we can enable such industries to further advance their leadership positions in our new global economy.

While an industry consensus is still emerging on the NII, the AEA would like to share a number of observations:

- The Congress and new Administration should work together to make the NII a top priority for the government and for the Nation.
- Encourage collaboration between industry, government, and academia through the establishment of the HPCC Advisory Committee and a mechanism for providing private-sector input on the NII. It will take the concerted efforts of all of these groups to deliver the maximum benefits of the HPCCI and the NII.

- An openly competitive national and international marketplace will provide significant incentives for the private sector to make the major investments in the NII wherever possible. The AEA believes that the nation will be best served through private enterprise initiative on the network, with vehicles to ensure universal access.

- Ensure that programs are in place to train thousands of application development engineers capable of developing parallel software.

- Government should quickly address unnecessary regulatory constraints. For example, regulatory constraints on frequency allocations for mobile and wireless computing must be addressed so these emerging technologies can become a viable U.S. industry.

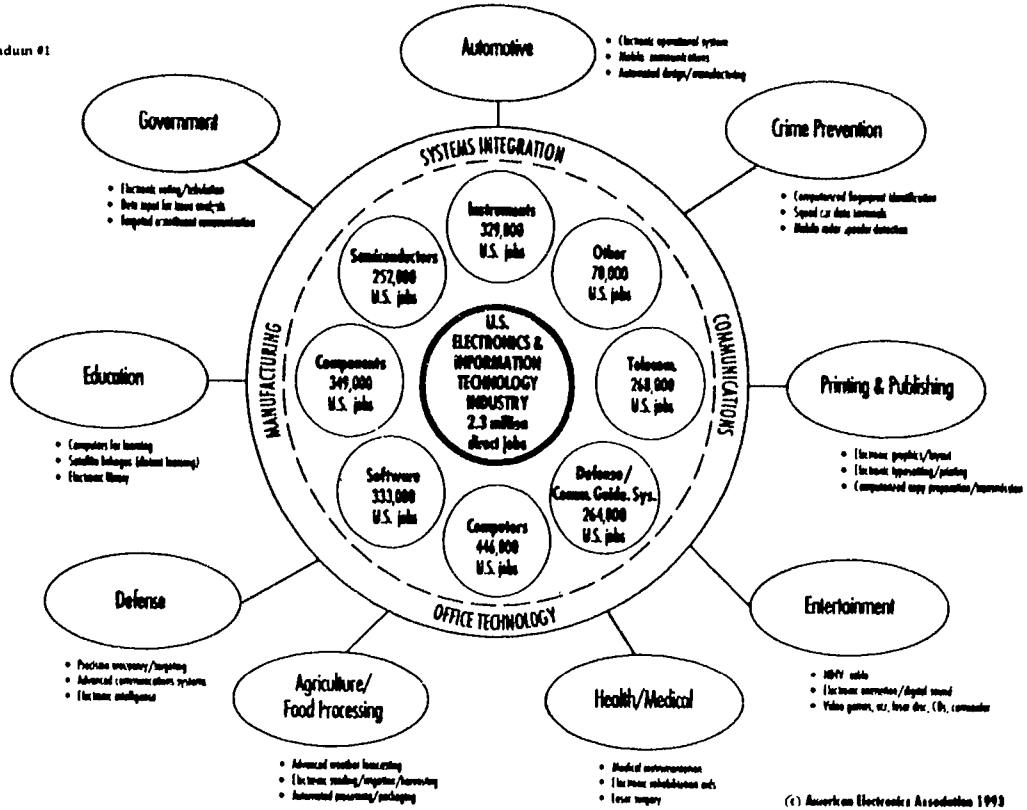
- Within the four targeted applications areas, the testbed implementation programs should move forward with a focus on maximizing the contribution to American competitiveness. Testbeds should employ technologies which can be transferred broadly throughout the public and private sectors in the near term.

In Closing

The AEA strongly endorses the intent and programs associated with the High-Performance Computing Act and the new National Information Infrastructure Initiative. We believe that by expanding the vision of HPCC, a broader industrial opportunity is emerging that can have an even greater impact than the current Initiative. The Association's members are anxious to work with both Congress and the new Administration to help leverage high-performance computing and communications technology into enduring leadership for American science and industry.

Electronics Drives Product/Process Improvement in Other Sectors

Addendum #1



Mr. KLEIN. Thank you very much.

Dr. Lindberg, both the President's technology paper and your statement referred to the creation of an Information Infrastructure Task Force. Is this to be a Federal advisory committee, which will have private sector members in addition to government members, or is it intended to be a government body that will receive private sector input through some of the means you have mentioned in your testimony, such as workshops?

Dr. LINDBERG. My understanding is that it would be a formally-constituted advisory body compliant with the Federal Advisory Committee Act and that it, therefore, would be made up of non-Federal members meeting to advise Federal officers.

Mr. KLEIN. In a similar vein, testimony of industry witnesses expresses concern that the Executive branch has not established the High Performance Computing Advisory Committee authorized by the 1991 legislation. Could you tell us the administration's plans with regard to that committee?

Dr. LINDBERG. I was asked by Dr. Gibbons what was the most important thing, in my opinion, to do to move this program forward, and my advice to him, my opinion, was the appointment of precisely that advisory council. I think that we need that to happen and I hope that, either by changing the law concerning whether the appointments need to be presidential, or by obtaining an opinion which would allow it to go forward more speedily, that that will happen. I think that you put your finger on a weakness and an important one.

Mr. KLEIN. Perhaps you could just clarify for us, what do you see as the obstacle or roadblock to the appointment of the committee at the present time?

Dr. LINDBERG. The law requires presidential appointments and the White House Personnel Office wasn't able to convince themselves that any of the short list or the long list of the people we felt were very, very fine candidates were without blemish. Anyway, they didn't appoint any.

Mr. KLEIN. I see.

I must say, I compliment the panel of experts who have enlightened us regarding the technical and scientific aspects of the high performance computing and communications industry and the technological advances that are presently being made and are anticipated to be made in the future. And, of course, this committee is most interested in that subject in terms of its ability to enhance American competitiveness.

In the case of Mr. Rodgers, it would appear that your testimony seemed to focus more on your political views than your technical views, and I'm just wondering, Mr. Rodgers, it's my understanding that your company—

Mr. ROHRABACHER. Mr. Chairman, Mr. Chairman, I would take objection to that last remark.

Mr. KLEIN. Well, you can object to it, but I object, frankly would object, to your applauding in the middle of his testimony, but I let it pass in any event.

Dr. Rodgers, it's my understanding your company lost money last year or in a recent year, and, as a result of that, moved some or all of its manufacturing operations to the Far East?

Dr. RODGERS. Thank you for giving me a chance to talk about my company's shortcomings. We have 1,500 American jobs. We were the last semiconductor company in the Silicon Valley to move our assembly and test operations offshore. Intel, Advanced Micro Devices, National, et cetera, had done it a decade prior.

Our earnings in terms of cumulative earnings, history to date, stand $101 million, which ranks us seventh among all U.S. semiconductor companies in total profitability. I'm extremely proud of our first decade of accomplishment, and I don't believe that two losing quarters last year out of 40 makes me any less capable of commenting on this topic than Andy Grove might have been, when Intel lost four quarters in a row in 1985.

Mr. KLEIN. I didn't suggest that it did, but did you move some of your operations to the Far East?

Dr. RODGERS. As I said, we moved 400 of our 2,000 jobs to the Far East, following the lead of every other company in the industry.

Mr. KLEIN. Well, would that suggest perhaps that the rising tide you're talking about lifted some sampans in the process?

Dr. RODGERS. The jobs we moved to the Far East were wire-attaching jobs which are done for 90 cents an hour, and I hardly think they have any impact at all on high technology. All of our wafers and chips are made in the United States in Minnesota, Texas, and California.

Mr. KLEIN. Well, I would think that some of the unskilled and semi-skilled workers in California who may have lost their jobs may feel differently on the subject.

Mr. Chairman, I see you've returned. I wonder whether you would like to resume the chair and—

Mr. VALENTINE. I hate to interrupt you.

Mr. KLEIN. I'm at a good point, if you would like. Thank you very much, Mr. Chairman.

Mr. VALENTINE. Operating under the five-minute rule, I will recognize other members who are present. I have a first on my list Mr. Rohrabacher, the gentleman from California.

Mr. ROHRABACHER. Yes, Mr. Chairman, I'm very pleased to be here and pleased especially to welcome our witnesses, including Mr. Rodgers, whose company is doing much better than the State of New Jersey, I might add, and has created more jobs than the Democratic administration in New Jersey. So we'll just leave it at that.

[Laughter.]

Mr. KLEIN. It's my—if the gentleman will yield—

Mr. ROHRABACHER. Yes.

Mr. KLEIN. —it's my understanding that Mr. Rodgers' company lost money the last two years, but, in any event, New Jersey would welcome Mr. Rodgers if he'll bring jobs to the state.

Mr. ROHRABACHER. Well, I'm sure that if the Republican philosophy of lower taxes and low regulations were in place in New Jersey, I'm sure you'd have a lot more companies there.

[Laughter.]

I'm very interested in this highway—we're talking about a superhighway, information highway, and what I'm interested in, to get down to the subject at hand, is that whether this is going to be a

superhighway, or should it be a toll road; and how do we make it work and how do we make it economically feasible, is what I'm interested in.

There are going to be costs involved in terms of users, and how does this all fit in? Frankly, I'm looking for some information here, and that's what a hearing's all about, if any of the witnesses have a suggestion or some ideas on this. How do we—who's going to pay for it once the system is set up? Yes?

Mr. BHATIA. I think the people who consume the services will pay for the services that they get. I think that the power of technology is that it can bring the cost down if there is an enabling environment for it. If in the natural course of evolution of communications networks telecommunications providers could expand their networks to provide all kinds of services, not just phone service, but video service, as well as data services, then they would be able to put those networks in and have the people who use those services pay for them.

Mr. ROHRABACHER. Is the technology available today? Because we're talking about something—what we're talking about is something that can be—people, whoever you are, can hook into the system. And is it possible for us to create a system that anyone can hook into, but then those people who are hooking into it will actually be charged for that service?

Mr. BHATIA. Yes, absolutely. In fact, the platform, the technology that we're offering at our company, is an open access kind of a platform that has the power of a switched network; that would allow all comers to be able to use that network, not just those that would be allowed by the facilities provider. It is very consistent with your dialtone, which allows for multiple suppliers of programming to make their product available to consumers.

Mr. ROHRABACHER. I was very impressed with your testimony earlier about your recent invention and wish you well in that.

Dr. Rodgers?

Dr. RODGERS. One misconception is that we don't have an electronic data highway. Right now coast to coast, border to border, AT&T, MCI, and Sprint have strong fiber optic cables. Gil Amelio, the current president of National, told me that he built the equipment to string 26 million miles of fiber optic high-speed cables prior to becoming the president of National.

The vision of the data highway is that you in your house will be able to access the Library of Congress, or dial up a movie from MGM, or whatever. And the problem is what you might call the last mile, the hookup of the current high performance data links to offices and homes throughout the country. That is uniquely a government problem.

For example, today what's hooked up to everybody's house? Cable. But cable can't carry data and telephone. If I were an engineer coming in from Mars and somebody said, "I want you to wire up the United States and I want you to have it done in three weeks," I'd say, "Long haul is optic, already done; short haul to everybody's house, 60 percent of all American homes, is cable, already done. Make the converters; hook them up, and you're there". But you can't do it—regulations.

The Baby Bells would love to hook fiber optic from the mainline cables into the homes. They can't do it, because they can only charge telephone bit rates, and they can't justify the investment. And other companies would like to do it with wireless communications, but they can't do it because they can't get the allocation of frequencies to do it. It's there. We need to let—turn loose the free market and let them make it happen.

Mr. ROHRABACHER. What—give me the first step. What law has to be passed or changed?

Dr. RODGERS. You recently passed a cable law, declared the cable a "natural monopoly." Natural monopolies aren't allowed to do things. So, for example, cable companies can't offer telephone service and they can't offer anything other than basic cable services. If you would turn them loose, they would be able to do a deal with other companies and start moving data across the country—already hooked up in 60 percent of the homes.

Mr. ROHRABACHER. Thank you very much.

Dr. LINDBERG. Mr. Rohrabacher, might I add something to that?

Mr. ROHRABACHER. Yes, sir.

Dr. LINDBERG. I think you ought to be aware that there is probably more than technical solutions to these problems, or more than one viewpoint. I'm firmly against the government regulating engineering standards. I certainly agree that that's a very poor policy.

But you should know that the manner in which HPCC and NSF have developed this Internet is strongly leveraged. Not more than one or two percent of the actual cost of all these networks are actually borne by HPCC Federal dollars. The vast majority, 98 percent easily, are Federal—are local, State, and regional enterprises. Consequently, of course, they operate under different rules. They set their own rules locally. The government has induced a tremendous investment in the private sector and the communities in this network.

Now, I think that that is the way in which these communications will ultimately reach down to every school and home and community in the country. They'll find their own way.

The policy concerning cable, cable TV and so forth, I think that's a very valid question to be undertaking, and I don't address myself to that. But I think that the variety of ways to accomplish this, and the amount of imagination the country can bring to bear to it, should not be underestimated. And the matter of local initiative that it will induce should not be underestimated. We don't have to pay more than one or two percent of the cost, and we should reserve those for disadvantaged communities.

Mr. VALENTINE. The gentleman's time has expired.

Mr. ROHRABACHER. Thank you.

Mr. VALENTINE. The lady from California, Ms. Eshoo, is recognized.

Ms. ESHOO. Thank you, Mr. Chairman. And thank you for holding this hearing.

And my thanks to the panel, that has taken a great deal of time and trouble and personal expense to come here to advise us.

I would just like to make some perhaps more of a macro statement to begin with. I have the distinct privilege of representing the 14th district in California, which is known as the home of Silicon

Valley, that has really led the way both for the nation and in many ways in the world. Those two words really do speak for themselves: "Silicon Valley."

I think, on some of the words that were chosen earlier, that we not diminish the importance of the President and the Vice President of this nation coming to the area to unveil their technology policy. That technology was put together through the very agile and bright minds of people that are not tied to any political ideology. What they forged was something that would be good for this nation and its people, and how we could, indeed, compete. And I don't think that I'm either understating or overstating the case, but I do think that it's important to state. Certainly, there is room for disagreement.

What I would like to hear from any member of the panel is how we can strengthen that technology policy on what you know and know so well, because that's what this country needs. People are not looking for Democratic answers or Republican answers. They are looking for answers that are going to fortify this nation, not only for the rest of this decade, but make us leaders in the next century and prepare our people to do so.

And I appreciate the patience of this committee, and its members, and the audience in hearing me out.

Now, on what you have come here to speak very specifically on today, I don't have a question of any specific person. I'd like to welcome Mr. Kalb, who's not only here on behalf of AEA, but also has a business in Sunnyvale, which is right in the middle of my congressional district. Mr. Rodgers is not within the borders of my district, but I remember very well coming to you and your employees during the course of my campaign, and I appreciated that invitation.

If you were going to take a specific slice of the technology policy, where would you change it, refortify it to fit into what I hope I described well in my opening comment?

Mr. VALENTINE. Mr. Kalb?

Mr. KALB. Thank you, Mr. Chairman.

I'd like to, to some extent, amplify on the comments that I made before. There has been a tremendous amount of very positive accomplishments in research made in the supercomputing centers, in the networking, and so on. What I think is most important for us as a nation, and from a competitiveness standpoint, is to move that out into the community at large. And I'll give you an example.

At least a year or so ago, the statistics were that about 70 percent of all the supercomputers in this country were in the government laboratories or major universities, and only about 30 percent of them had ever actually been deployed into industry. Interestingly enough, the statistics in Japan are exactly the opposite: 30 percent in government laboratories, 70 percent in industry.

Recently, one of our employees visited there with the intent of selling electronic CAD solutions on massively parallel systems. Every one of the companies they visited apologized because they didn't have the latest supercomputer; they only had the last generation.

And having spent 25 years in the semiconductor industry, and knowing almost every one of the major players in it, I can tell you

that there are essentially none in the United States that use supercomputing as a regular part of the design of their systems or of their processes, et cetera. And even to the extent they might, it's clearly not to the level of others.

I'll give you another example. One automotive company in the United States uses supercomputing heavily to design for the 30-mile-per-hour side impact crash regulation. Because of that, they can design to 30.5, reducing the weight, actually making the car safer because they can test more possible combinations, and so on. Another major company in the United States who doesn't use so much of that, designs to 35mph. What is the difference in having to design to almost 20 percent greater strength? More weight, poorer fuel economy, et cetera.

I believe the focus needs to be on training the infrastructure necessary to take these technologies which we've developed in our laboratories, which are there, which are exportable, which can be used, and moving them out to the much greater general populace. And that's going to require training. It's going to require focus on making systems affordable, and so on. But when we do that, the whole country becomes more competitive and it will be a great stimulus in building our economy.

Ms. ESHOO. Thank you.

Mr. VALENTINE. Mr. Rodgers—Dr. Rodgers?

Dr. RODGERS. Thank you, Mr. Chairman.

Today I've heard about better designed semiconductors, more computers in Japan. Fijitsu just reported that they would lose $322 million this year, which outweighs even the few million dollars of which we made such a large point of earlier. So supercomputers don't guarantee competitivity—competitiveness, excuse me.

Now, we can design better cars. We could design chips faster, but my choice in the free market was: do I spend $20 or $10 million for a supercomputer, or do I buy 100 workstations? And in our industry, my return on investment says, "workstations". That may not be true elsewhere.

We've heard stories about cans that don't dent as easily being designed by supercomputers. That's all great. And if those ideas are so great, then companies who could make profit on those good ideas should support them, not the taxpayer.

Mr. VALENTINE. Thank you.

The lady's time has expired.

The Chair recognizes the gentleman from Michigan, Mr. Smith.

Mr. SMITH Mr. Chairman, thank you.

Dr. Rodgers, I'm trying to figure out whether you're sort of dumb, making the suggestion that you shouldn't use the $3 to $4 billion that government is suggesting that they charge taxpayers to help with the superhighway and the applications, or whether you're courageous. I suspect I come down on the side of you being courageous to suggest what appears to be in your best interest, if other taxpayers would pay for building that superhighway and finishing up the last links and for training.

And I guess I would like to hear your thoughts on if it will be done—if the government doesn't put this money in, will that—will the private sector really complete the project? Will it be done? And

what kind of a time frame would you suspect it would be done in, if we were to save the taxpayers that $3 billion?

Dr. RODGERS. For the electronic super data highway, as I said, we already have millions of miles of fiber optics strung and it's a matter of getting government regulations put aside, so companies who are eager to do it can just go off and do the job.

With regard to supercomputing, although I disagree with Jeff here on my left, the fact is I'm an investor in his company. So I'm betting on his success. And the private sector, therefore, is taking care of MasPar. So we have a handful of supercomputer companies and high performance computer companies, and that's great. The private sector is taking care of it.

So my belief is what L. J. Sevin said: change is happening. The venture capital community is taking care of it. The government doesn't need to strap the taxpayers with any more bills.

Mr. VALENTINE. Mr. Karin?

Dr. KARIN. Yes, thank you.

Mr. VALENTINE. Dr. Karin?

Dr. KARIN. I'd like to make two comments, one just for the record. The aluminum can example was not paid for by the government, was paid for by Alcoa, and was not paid for at a subsidized government rate, but in fact the Alcoa involvement with the Pittsburgh center subsidized the Pittsburgh center, the government's activity. I didn't want a misconception to be made that Pittsburgh was doing the design for Alcoa, at either Pittsburgh's expense or the government's expense.

The programs within the Science Foundation's Supercomputer Centers that are involved in the industry are bringing this technology to industry, but not in a giveaway program. Industry contributes and subsidizes those programs.

My second point is, I'd like to answer Ms. Eshoo's question. I think that one of the roles for government, not the only one, in this arena where one can't expect the free market to take a role, is in our education infrastructure. In our society, the government pays for education, and it's necessary in our educational system, if we're going to turn out capable researchers for the future, that these technologies are available—whether we're talking about desktop machines, supercomputers, information highways, or whatever. And the government has a major role to play in seeing to it that in the entire spectrum of high performance computing technology, National Information Infrastructure, and so on, that these technologies are brought to K through 12, undergraduate universities, graduate research, and education activities. And I believe that is an appropriate role, and it has been a role in the past. I'd encourage you to extend that.

Mr. SMITH Mr. Chairman, do I have any time left? He was sort of answering somebody else's question.

Mr. VALENTINE. Yes, sir, I think you've got about a minute. We have tried to be not too formal, but—

Mr. SMITH Maybe I would just follow. Mr. Karin, are you suggesting that the private sector, and that part of the industry that has the most to gain in assisting with that education, in that kind of proper education, shouldn't contribute or be part of that education?

Dr. KARIN. No, not in the least. I'm just suggesting that you can't expect the—we don't have a school system, in general, in this country, that is self-supporting on a free market competitive basis. You could theorize about such a system. It's not the system that we generally have, with some minor exceptions to that. The government traditionally funds education. If we're to change that, we could discuss that, and then you could change the way you introduce these technologies in that educational system.

Mr. SMITH I guess I'm concerned that the success rate that we've had would lead me to believe that maybe it's in our best interest if the industry that's going to—that is better able to define and describe the kind of training necessary, would be maybe closer, more closely involved with that training.

Dr. KARIN. I don't have any disagreement with that. I'm just pointing out that currently the—and, in fact, industry is involved, which is my point about the cans, and the system is providing something. Industry is willing to pay for it. And I have other examples that we don't have time to go into in detail here.

Mr. VALENTINE. I think the gentleman's time has now expired.

The lady from Maryland, Ms. Morella.

Ms. MORELLA. Mr. Chairman, I'll defer to the ranking member of the full committee.

Mr. WALKER. No, go ahead.

Ms. MORELLA. Thank you.

I just want to welcome the panelists, and thank you all for coming and giving us the benefit of your personal experiences and your feelings about this issue. I wanted to particularly welcome Dr. Lindberg, because he has put into effect the bill that had been passed that dealt with the High Performance Computing Act of 1991, because he is the Director of the National Coordination Office for High Performance Computing and Communications in Bethesda, as well as being the Director of the National Library of Medicine, and our NIH representative to FCCSET.

So I wanted to just pose a question and ask if you might briefly respond. What is it you would do, to perhaps amend or to change that particular act of 1991? And I guess I'd start out with Dr. Lindberg, briefly. Since you've had an opportunity—you'd probably say it's great and all, but if you could change something or add to it, what would you do? And if any of you would like to offer any comment with regard to how you see that particular legislation as it is now starting to be implemented—Dr. Lindberg?

Mr. VALENTINE. Yes, please proceed.

Dr. LINDBERG. Well, of course, I do like the act and I do admire it, and I am working on its behalf. But I think that the suggestions that were made in S. 4, that Mr. Gore made in 1992, to superimpose on this applications in health care, education, life-long learning, digital libraries, and manufacturing are wise. I think that support ought not to be taken away from the basis research and development that the act calls for, but adding to it relatively modest amount of monies, for an emphasis on applications would strengthen the program, and would make it more understandable to the public, and we'd get benefits to the communities faster. So I like the improvement in the act very much.

And the only specific change I guess I would recommend is that apparently, for reasons that are legal and escape me, the requirement that the President personally appoint the Advisory Committee seems to be an obstacle to getting the Council appointed. So I guess that that ought to be changed, but that's perhaps just a personal view, and may not be an administration point of view.

Mr. KALB. I'd like to reinforce the notion that it is important to get this advisory panel in place. This is something that industry has been looking for. It is one of those areas in which industry could play a much greater role. As we were talking about earlier, we've heard this now from a couple of different dimensions: that if we're going to move this forward, we're going to need more interaction from industry, maybe more investment from industry as well, which usually, by the way, follows interaction from industry. We tend to follow, and somehow open our wallets, sooner or later.

But the keys, from my perspective, would would be getting that in place, getting that advisory board actionable, making the industry more involved through that and through other mechanisms. And, as I've pointed out earlier, then getting that training and reaping the benefits of the investments we've made. We don't want to let them sit.

Ms. MORELLA. Do you believe, as Dr. Lindberg suggested, if it was not to be presidentially appointed, that it would work faster?

Mr. KALB. I don't have enough insight into the workings of how that gets done to make a comment.

Ms. MORELLA. There are plenty of—

Mr. KALB. But all I can say is I don't think it needs to be appointed by the President.

Ms. MORELLA. Okay.

Mr. KALB. As long as someone with good insight into the requirements makes that appointment, I think that should be satisfactory.

Ms. MORELLA. If no one else has any comments, then I defer back to the chairman. Thank you.

Mr. VALENTINE. We thank the lady.

The Chair recognizes the gentleman from Pennsylvania, Mr. Walker.

Mr. WALKER. Thank you, Mr. Chairman.

And, first of all, I'd like to say to Mr. Rodgers, I know the last time you testified before the committee, you testified at the behest of the majority, and we welcome you back. I assume at the time that you testified for the majority, you were not subjected to the kind of personal attack you took earlier today, and, for that, I apologize. You know, the fact that you're here for the minority, we do appreciate your being here and appreciated your testimony.

One of the models that's being used for many people who are looking at these kinds of issues is the SEMATECH model. We are being told that the fantastic success of SEMATECH is the reason why we ought to use that as a way of getting into industrial policy in all kinds of other areas. I'm wondering, Mr. Rodgers, whether you'd comment from your perspective in the industry about whether or not you think that this is a model that we ought to replicate in a number of other phases of the high-tech industry.

Dr. RODGERS. The last time I did appear in front of this committee was at the request of Mr. Valentine, and I was very, very well

treated, and I thank you much. It so happens that particular testimony, which is available, was primarily against SEMATECH, which I considered to be a very inefficient use of government money.

I can say that SEMATECH is reasonable, on the government scale of collaboration and throwing money at a problem, a reasonable effort in that scale, but that it is very inefficient. A couple of statistics: government has thrown now a billion dollars at SEMATECH, committed a billion and thrown $600 million. And it is supposedly for the semiconductor industry; yet, 200 companies who could walk up and pick that money up essentially for free, of the 200 companies eligible, only 14 signed up for SEMATECH. And since that time, two of them have quit and two more are talking about quitting.

Right now, I have no philosophical objection to SEMATECH other than the tax-and-spend aspect of it. And we aren't members of SEMATECH because we would only have to pay $2.75 million a year for SEMATECH, and it's not worth it. I would rather have 27 PhDs at Cypress working on supercomputers and data highways than I would be a member of SEMATECH. Its efficiency is extraordinarily low.

In the beginning, SEMATECH did some things that were wrong. They gave money to the equipment industry, and they signed contracts with the equipment industry, the people that give us wafers, make wafer-making equipment, that they would make special new equipment which would be withheld from the market. The new president of SEMATECH has stopped that practice, but that's what brought me to Congress. Now SEMATECH is simply bad return on investment.

Mr. WALKER. Well, I thank you for that.

And you also in your testimony—and it was interesting that you indicated that President Clinton and Vice President Gore visited Silicon Graphics, a company in Silicon Valley, when they were out there recently, and in your testimony that you didn't get to present, you indicate that Silicon Graphics is probably an example of why you would not want to go the government route. I think you indicate in your testimony that you even own some shares in Silicon Graphics. Could you give us a bit of perspective on that?

Dr. RODGERS. Silicon Graphics is another investment of ours. They're a neighbor of ours. They're a customer of ours. That face that was "morfed" from that of President Bush to President Clinton, to the amazement of the audience, was morfed on Cypress memories. We advertise together. The supercomputer effects that they did in *Terminator 2* were done partly with our chips, and we co-advertise together.

I just would like to point out, Silicon Graphics is a venture capital startup, not the output of a government program.

Mr. WALKER. Okay, thank you.

Thank you, Mr. Chairman.

Mr. VALENTINE. I thank the gentleman.

Before I recognize the gentleman from Ohio, Mr. Hoke, let me say to Dr. Rodgers that, of course, the fact that you were invited here by the chairman of the committee is an indication of our search for all sides of the question—

Mr. Hoke?

Mr. HOKE. Thank you, Mr. Chairman.

Mr. VALENTINE. —and fairness and purity and justice.

[Laughter.]

Go ahead.

Mr. HOKE. And the American way.

Mr. VALENTINE. Right. Apple pie, yes, will be served on the break.

[Laughter.]

Mr. Hoke, fire away.

Mr. HOKE. Thank you very much.

First of all, I would like to thank the panel. And I'd particularly like to thank Dr. Gage for coming from Cleveland. I have particular interest in the Cleveland Advanced Manufacturing Program. I spent some time there about a month ago, and was impressed with two things.

And that was, first of all, that's been a successful collaboration; that there has been some efficient use of taxpayers' money in the CAMP program, and there has been some extremely inefficient use of the taxpayers' money. And it seemed to me that the people that I met there had some real insight, having been in the business of trying to specifically help small and medium—small medium-sized companies with their manufacturing process. And these are mostly low-tech or no-tech industries that actually were able to use a couple of different aspects of the CAMP program.

First of all was just the bringing together under one roof of a wide array of technologies, almost like a trade show that was a permanent exhibit of CAD-CAM different measuring devices, balancing devices. It was very impressive. And my understanding is that that was extremely helpful. And my understanding about that was not from self-serving comments from the CAMP administrators, but from actual people who had been aided by it.

The other thing was that there was a lot of intelligence that CAMP brought in its ability to bring really manufacturing expertise to these low-tech industries that had not had the benefit of those, of that kind of expertise.

And, Dr. Gage, what I would like to ask you has to do specifically with your advice to those of us who are commissioned to be stewards of the taxpayers' money, as to what you can tell us about what are the most effective things—what are the most effective things that you have done? What are the least effective? How can we avoid wasting money in this program? And how can we spend money in a way that will truly aid those small businesses, that don't appear to have access to the information that they need?

Mr. GAGE. Thank you, Mr. Hoke. I'm delighted to have a chance to comment on these several questions.

The first observation that I'd make is that CAMP was established in late 1983, early 1984, and really served a five-year apprenticeship program, working together with the educational institutions in the community and with hundreds of companies. So we had some considerable time to learn about what worked, and what didn't work, before we received the award from NIST to establish us as a Manufacturing Technology Center. I think that's very important, and I believe that our success over the past four years as

a Manufacturing Technology Center was due very much to the fact that we had that experience and those connections with the small or medium-sized companies in the community. I just can't overemphasize that.

And, in fact, it does concern me that we might attempt too rapid an expansion of such facilities across the country, without those activities being rooted in the community, and rooted in the manufacturing companies in the community.

I think that one of the most—

Mr. HOKE. If I could interrupt for a moment, I recall when I was there that I believe that the President's proposal has been—was originally to establish 150 of these units. I think that's been pared down. But hasn't CAMP—wasn't it part of an analysis initiative that had a very different idea about how many are needed to be efficient in this area?

Mr. GAGE. Well, we began work about a year and a half ago, looking at where the industry clusters occur in the United States, what are the nature of those clusters, and what type of service structure might be established to help service those structures. I think one of the points of reality that will begin to settle over this whole effort, over the next couple of years, is that there is no way that we can mount a program to put into place 150 meaningful and useful centers in a very short period of time. We're going to have to grow that capability.

The Agricultural Experiment Station system was not built in a year, either. It took—it evolved over many decades. And I think we may be able to shorten that time, but we still need to qualify institutions; put them through an apprenticeship program, if you will; make sure they perform. We went through our own three-year review, as mandated by the Congress, and we received good marks, so we were able to continue on. But we shouldn't let up on that quality at all, in the haste to establish new organizations, but work very hard to try to help build in all the communities where there are meaningful clusters of companies, and I'd say that's probably at least a minimum of 1,000 manufacturing companies.

We need to start putting together at the local and state level networks of service providers. A lot of them are already out there, providing a piece here and a piece there, but not a comprehensive set of services. And if we can let the idiosyncratic nature of this country be exerted through a program for manufacturing excellence, and not build too much inflexibility in, too much central control, then I think we will be able to move even faster and more effectively.

Mr. VALENTINE. The gentleman's time has expired, and we've got to go vote—

Mr. HOKE. Oh. Can we come back and ask some more?

Mr. VALENTINE. —lest we miss it. Well, I hesitate to—how much more do you have?—I hesitate to ask them to stay here through another session over there. There might be more than one vote.

Mr. HOKE. I just want to follow up very briefly with the idea of where you would specifically say that we shouldn't be engaging in efforts.

Mr. GAGE. Well, you saw there on the floor of our manufacturing resource facility about $6 million worth of hardware and software

equipment. If we had that investment to make over again, we would not do it. I think that that is one of the lessons that ought to be forcibly communicated to each and every start-up manufacturing assistance center across the country. That money was provided not by the federal government. It happened to be provided by the State of Ohio; but, nonetheless, it was not the best use of that money. So don't build either edifices, or don't build collections of manufacturing equipment, which can be very quickly outdated.

Most of the work we need to do, we have found in helping the small or medium-sized manufacturing companies in this country, is head work. It's not a lot of equipment and a lot of building.

Mr. HOKE. Thank you very much, Dr. Gage.

Mr. VALENTINE. We are—yes, we would ask you gentlemen if you would be willing, within reason, to respond to questions that members of the subcommittee, including the chairman, might submit to you in writing.

We have a vote. Rather than to ask you to trespass any further on your patience and ask you to sit here, we will conclude this hearing with our very special thanks for the preparation and for your testimony.

[Whereupon, at 3:25 p.m., the subcommittee adjourned, subject to the call of the Chair.]

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